DOCUMENT RESUME

ED 315 037 IR 014 144

TITLE	The Introduction of Computers in Schools: The Norwegian Experience. Examiners' Report.
INSTITUTION	Organisation for Economic Cooperation and Development, Paris (France). Centre for Educational Research and Innovation.
REPORT NO	ISBN-82-90707-15-0
PUB DATE	Nov 87
NOTE	70p.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Computer Assisted Instruction; Courseware; *Educational Planning; Elementary Secondary Education; Foreign Countries; Microcomputers; *National Programs; Program Evaluation
IDENTIFIERS	*Norway

ABSTRACT

This report on a 4-year (1984-87) project to introduce computers into the Norwegian schools begins with an overview of Norway's geography and climate, people, foreign policy, economy, recreation, and educational system. Background on the development of the national plan for the introduction of computers into the schools is then provided together with statements on aims, objectives, important tasks for central administration, and the establishment of a task force. The achievements, problems, and results of the project are summarized. Conclusions and recommendations by independent examiners, appointed by the Organisation of Economic Cooperation and Development (OECD) are discussed under nine broad headings: (1) the next phase of the project; (2) funding and time scale; (3) organizational issues; (4) curriculum; (5) software development initiatives; (6) teacher training initiatives; (7) dissemination of information; (8) equipment issues; and (9) research and evaluation directions. Two appendixes contain a list of participants in the meetings organized for the examiners' visit and the text of the revised background paper, "Computer Technology in Schools: The Norwegian Programme of Action." (MES)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Centre for educational research and innovation (CERI)

ED315037

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

The introduction of computers in schools:

The Norwegian experience.

Examiners' report

IR014144

OCDE
OECD

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

J.R. West

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

THE INTRODUCTION OF COMPUTERS IN SCHOOLS: THE NORWEGIAN EXPERIENCE

EXAMINERS' REPORT

CENTRE FOR EDUCATIONAL RESEARCH AND INNOVATION

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

GENERAL DISTRIBUTION
Paris, November, 1987

This report has been prepared by a team of independent experts, nominated by the OECD in consultation with the Norwegian authorities to serve as examiners for the review of the Norwegian experience with the introduction of computers in schools, and following an eight-day visit to Norway in September 1987. The examiners had at their disposal a large number of background reports and attended presentations by individuals and organisations who were actively involved in the four-year (1984-1987) National Experimental Programme for the Introduction of Computers in Norwegian Schools. The examiners' itinerary also included opportunities for them to hear the views of a wide range of individuals not directly involved in the work of the National Programme.

The report is in two parts. Part one includes the aims of the Norwegian programme as outlined in the Norwegian White Paper (St.meld nr.39, 1983-84) and its results as evaluated by the Norwegian authorities and documented in the Background Working Paper, prepared by them, as a working tool for the examiners: «Computer Technology in Schools: the Norwegian Programme of Action» (August 1987). The second part of the report presents the conclusions of the Examiners' Group and their suggestions for the future.

The members of the Examiners' Group were:

Alfred Bork
Professor and Director of the
Educational Technology Center
University of California
Irvine, United States

Sandra Ann Crapper
Resources and Information Manager
ILEA Educational Computing Centre
London, United Kingdom

Jacques Hebenstreit
Professor and Head of the
Computer Science Department
Ecole Supérieure d'Electricité
Paris, France

The examiners and the OECD Secretariat wish to express their thanks to the Norwegian Ministry of Church and Education and particularly to Mrs. Marit Granheim, Senior Executive Officer, for the excellent arrangements made for their visit and the openness of the discussions which took place on that occasion.

The views expressed in this report are those of the authors and as such do not commit the OECD nor its Member countries. This report has been made public on the responsibility of the Secretary-General of the OECD.

Copyright: Report - OECD Annex
- Norwegian Ministry of Church
and Education
ISBN 82-90707-15-0
Engers Boktrykkeri A/S, Otta

CONTENTS

NORWAY: THE COUNTRY AND ITS EDUCATIONAL SYSTEM 7

I. CONTEXT AND IMPLEMENTATION OF THE PROGRAMME 10
Background 10
Aims and Objectives 11
Strategies 13
Results 18

II. THE FUTURE: PROPOSALS AND RECOMMENDATIONS 21
The Next Phase 21
Funding and Time Scale 22
The Organisational Issues 23
The Curriculum 23
Software Development Initiatives 29
Teacher Training Initiatives 33
Dissemination of Information 34
Equipment Issues 36
Research and Evaluation Directions 37

Appendix: List of participants in the meetings organised for the examiners' visit. 38

Annex: «Computer Technology in Schools: the Norwegian Programme of Action» (November 1987). Revised background paper prepared for the OECD Examiners' Group. 43

NORWAY: THE COUNTRY AND ITS EDUCATIONAL SYSTEM

The Country

Geographically, Norway is unique. Few other places in the world have 4 million people living so far north, in a country that is mostly mountain and barren land. Almost half the country lies to the north of the Arctic Circle. The fact that people can live so far north in Norway is due to the Gulf Stream and the westerly winds which ensure a mild climate all the year round. For most of the country the July temperature is 15-17°C, and the average annual temperature 3-6°C.

The People

Norway is a sparsely populated country with 4 million inhabitants. About 70 per cent of all Norwegians live in densely populated localities, i.e. towns and cities.

Some 20 000 Norwegians of Sami extraction live in Norway, mostly in the far north. Only 10 per cent or so of these are reindeer breeders.

There is complete religious freedom in Norway. About 90 per cent of the population belong to the Evangelical-Lutheran Church of Norway.

Form of Government

Norway is a fairly new nation. Her constitution, a constitutional monarchy with a parliamentary system, came into being on the 17th of May 1814, even though true independence did not come until the final break with Sweden in 1905. Executive power is formally vested in the King, but it is exercised through the Council of State (the Cabinet), which is dependent on the confidence of a majority in the National Assembly, the Storting.

Norway is divided into 19 counties and 454 municipalities. There is an extensive system of local government on both the county and the municipal level, based on elections every fourth year, held midway between the national elections.

Foreign Policy

The Nordic countries share a comprehensive community of language and culture and co-operate closely. Norway participates in all the specialised agencies of the United Nations, has a trade agreement with the European Economic Community (EEC), and is a member

of the Organisation for Economic Co-operation and Development (OECD). The country's security policy is linked to NATO.

Economy

Like other Western European countries, Norway has seen her economy undergo radical changes since World War II. The primary industries have shown a marked decline, while industry's share of the national product has increased. The service trades' increasing share of manpower and of the national product is particularly striking. The oil and the electronic intelligence sectors are growing and expanding at a brisk rate.

The oil and gas fields on the continental shelf in the North Sea constitute one of the country's most important natural resources. The availability of cheap hydraulic power has been of decisive significance for the country's economic development. Other important natural resources are forests, fish and ores. The principle trades are agriculture, fishing, shipping, oil, service and other industries.

Taxes and duties are high in Norway but must be seen in the context of social welfare and egalitarian policy. The unemployment rate is low compared to other European countries. The age of retirement is 67.

Recreation

In Norway there is almost unlimited access to open country and forest land. Only cultivated land may be fenced in. Norwegians are enthusiastic about outdoor life - for instance cross-country trekking, angling, swimming, camping and boating in summer and skiing and skating in winter. Skiing has been called the Norwegian national sport, cross-country skiing in the woods and mountains being especially popular.

The Educational System

The Norwegian educational system is predominantly a public one. Schools and universities are run by the public authorities, and education is free at all levels. About 850 000 people receive their education in schools, universities and other educational institutions every year. Of these roughly 550 000 are students in the compulsory elementary schools. The teaching personnel amounts to about 50 000. In addition to ordinary school attendance, there are approximately 1 million participants in adult education.

The National Assembly determines the basic pattern of education by laying down the aims, structure and contents of educational provision by legislation. The Ministry of Education acts in professional and pedagogical matters on advice from expert bodies, for instance The National Advisory Council for Primary and Lower Secondary Education and The National Advisory Council for Upper Secondary Education. During the last years a trend towards greater decentralisation of educational authority from the Ministry to regional or local education authorities has been fur-

ther implemented. This is now being applied even to the financial sector, allowing the counties and municipalities to have a greater influence on how sums of money allocated to them are to be spent.

Basic school education

The municipalities are responsible for building and running the nine-year basic school. In every municipality there is a local school board, assisted by a chief education officer.

The basic school is divided into a six-year lower stage (primary), and a three-year upper stage (lower secondary). Basic school attendance is compulsory for all from the age of seven. The school is completely comprehensive, with very little organised differentiation outside the classroom.

A fundamental principle is to integrate, as far as possible, all handicapped children into regular basic schools to ensure they receive the education they are entitled to.

The structure of compulsory schooling in Norway is rather decentralised, and there is a relatively large number of small school units. The number of schools where there are no separate classes for all age grades amounts to about 1 000, and about 250 of these schools are ungraded, that is to say that all students are brought together in one and the same classroom. All students with a Sami background who live in the central Sami districts are entitled to be educated in their mother tongue in all subjects.

Upper secondary education

The counties are responsible for building and running the upper secondary schools. Upper secondary education, which is also relatively decentralised, includes almost all education facilities between the compulsory school and higher education. This comprises education for students from the tenth to the twelfth school year, or students mainly from 16 to 19 years of age.

Upper secondary education is regulated by one particular act which aims at co-ordinating all training in general and vocational subjects in a comprehensive upper secondary school system. One of the fundamental objectives of the Act is to give equal status to practical and theoretical education. Thus, general and vocational studies exist side by side at the same school, and can even be combined within one and the same course.

Because handicapped students in Norway have a right to receive adapted training according to their skills and qualifications, priority is given to the handicapped when admitting students to upper secondary education.

The overall goals of Norwegian education may be summarised as follows: transmission of knowledge, skills and cultural values, equal opportunities both in education and work, increased attention to the needs of disadvantaged and handicapped groups and further democratisation of education - all this being pursued in the general context of lifelong learning.

I. CONTEXT AND IMPLEMENTATION OF THE PROGRAMME

BACKGROUND

It seems that the very first suggestion for a national plan to introduce microcomputers into the Norwegian educational system started in the early eighties.

At that time the idea was put forward by the Cabinet of the Ministry of Church and Education to introduce computers into schools with the intention of investigating whether this tool could improve education. In a world where computers are pervasive it was also considered to be worthwhile to allow young people the chance to explore the many uses of computers, in the hope that this would improve the qualifications of the future citizens of the Norwegian society.

There were already a number of microcomputers available in schools which were used to some extent at primary level, but mainly within secondary level education. However, the main use of these computers was to teach either computer literacy, computer science or programming.

At the end of 1982 a group was established which visited France, Sweden and Scotland, and undertook preparatory work towards a Programme of Action.

Early in 1983 the Government approved the preparation of the Programme of Action and also the preparation of a standard hardware requirement suitable for education.

In May 1983 the Bårdshaug Conference took place, which brought together 40 to 50 participants, including teachers who were already using computers, to discuss the content of the governmental plan.

During September 1983 the general content of the White Paper No. 39, was defined. It was accepted by the Government at the beginning of 1984, and approved by Parliament in Spring 1984.

A little earlier, after lengthy discussions with two computer manufacturers, contracts were signed with them to supply microcomputers to Norwegian educational institutions.

The following quotes describe the Norwegian government's aims and objectives and are taken from the report «Computer Technology in School», Report to the Storting No. 39 (1983-1984), published by the Ministry of Church and Education, Oslo.

10

AIMS AND OBJECTIVES

Major Aims

«The Ministry has decided that it will give initial priority to the following areas.

1. Experimental activity at selected schools:
   - Where teaching in computer studies and use of computer technology in the rest of the school's teaching is seen as a coherent whole;
   - Where the school as a whole joins in the planning and where all categories of teachers are involved in the use of computers as an aid;
   - Where the outside specialist support, additional training for teachers, and experience, subject and pedagogical qualifications can be developed which can be used in later guidance and teacher training activities.
2. Development and testing of teaching programs or aids which provide pedagogical support for teaching in many subjects and are compatible with the school's social and cultural aims.
3. Mutual co-operation between schools of the same kind and schools of different types, computer specialists both inside and outside the school system, colleges and universities which provide teacher training.
4. Building up a national network of resource centres and personnel in the different groups of subjects to provide the necessary support the school system requires for developing qualifications and the opportunity for sharing experience. This can be done, for example, by means of conferences, courses and exchange of materials, for groups of teachers.» (p. 24 of the above-mentioned report).

Sub-Aims

«- To create such necessary conditions for teaching computer studies as will prevent the emergence of new class divisions;
- To develop the educational system's own resources of expertise by creating conditions for development work and research, based on initiative generated in schools and specialist centres;
- To involve individuals from all disciplines in trial teaching and debate on the place of computer technology in the school;
- To stimulate the development of qualifications in all branches of the school's system, as for example guidance, steering bodies and specialist advice;
- To organise collaboration across the boundaries of different types of schools and different educational levels, in order to exploit existing knowledge and experience to the fullest possible extent;
- To stimulate extensive collaboration between the education sector at all levels, as well as trade and industry;
- To develop further collaboration between home and school by concrete co-operative projects within computer teaching;

- To stimulate experiments in the use of computer technology in special education, and the collection, systematisation and dissemination of information on the experiences in this area;
- To seek better ways of learning with the aid of computer technology.

To achieve these aims the use of computer technology as a pedagogical tool or aid will be one necessary factor in many areas and in many subjects.» (p. 23).

Objectives

The Ministry identified as a major objective the need to investigate the use of the computer as a teaching aid, and foresaw possible changes occurring in the curriculum. It also recognised the need to instigate an in-service training programme as part of the national initiative.

«As a teaching aid in the school, computer technology is a newcomer. If developments in many other countries are taken into consideration, the time seems ripe for trials on a broad front both in the lower and upper secondary schools. The Ministry considers it very important that work on trials and development should be stimulated within the traditional subjects with regard to content and method. To give an awareness of what computer technology can mean for the individual, contact with computer equipment must be organised so that the pupils get varied experience of what data processing can be used for.» (p. 16).

«In time, experience gained from the teaching of computer studies and the use of computers in other teaching will provide a basis for changes in curriculum, partly because methodical assumptions will have changed and partly because new technology gives the opportunity for a new content.

For in-service training of most teachers it means that computer technology as a teaching aid should have priority. The teachers of the various individual subjects should have a good training in subject methodology and therefore be able to distinguish good software from bad. They should receive training which enables them to experiment themselves with the computer as a tool within the teaching of their own subjects.

How the objectives of teaching computer studies can be realised through syllabuses, methods and organisation of teaching will be central elements in a trial phase. Attempts must also be made to find out at which stages different uses of computer teaching can best be introduced.» (p. 21).

Important Tasks for Central Administration

The Ministry stated that «important tasks for central administration in the coming years» would be as follows:

«- To buy in good software, especially for the areas which are lagging be-

hind in this respect. Sources of supply can be manufacturers of computer hardware, publishers, business, teachers, schools and other public or private institutions;
- To commission trials and adaptation of software that has been bought in;
- To stimulate development of programs, for example through courses and direct support of development and production;
- To make agreements, where necessary, with data centres on availability of software libraries;
- To contribute to the development of a distribution procedure for software;
- To ensure the necessary maintenance and updating of programs that the schools can use freely;
- To be responsible for the evaluation of educational software;
- To consider the question of an arrangement for giving official approval to teaching programs;
- To stimulate the building up of national expertise in evaluating teaching programs.» (p. 19).

Establishment of a Task Force

The Ministry discussed in the White Paper the possible problems arising from establishing this initiative either as a central or decentralised model, as follows:

«What seems to emerge is that an action programme which is either based solely on a centrally controlled model for development, or alternatively on a completely decentralised model, would have little chance of success. The issue turns on what are, in some measure, considerable changes in attitudes and behaviour in the classroom - changes which can hardly be controlled by central authorities. On the other hand, the development will demand so much concentrated effort in in-service training and development that it is unrealistic and inappropriate to base development completely on relatively small and weak units, which the schools are after all. The programme must give the individual school as great a freedom as possible in development work, and at the same time extend regional and central measures which ensure quality, continuity and learning experience across the boundaries of different kinds of schools and different regions.

A programme of action must have the character of a set of government measures which can provide guidance in the desired direction for the development in different areas of the school's activity and within all branches of the school system.» (p. 22).

STRATEGIES

One important strategic aspect was the decision to have the results of the Action Programme evaluated by an external Norwegian body, i.e. IMTEC (International Movements Toward Educational Change, The international learning cooperative), hwo are private

consultants. Another important strategic decision was the creation of a Task Force (15th October 1984), whose task it would be to implement the Programme of Action. However a number of activities did start before the official creation of the Task Force.

As early as May 1984 (five months before the creation of the Task Force), schools were invited to apply to become an experimental school and in October 1984, eight schools were selected, and in March 1985, 13 further schools were selected, which implies that the whole school (administration and teachers) was willing to participate in the Action Programme. An additional 20 schools, designated Project Schools, also participated in the Programme of Action, but to a lesser extent, mostly with only a group of teachers in each school using microcomputers.

Early Days

In order to provide the readers of this report with an insight into the experiences of the Task Force during the first part of its existence, the examiners have taken the following quotes from the provisional version of the background working paper, «Computer Technology in Schools: the Norwegian Programme of Action» (August 1987). This report has now been revised by the Norwegian authorities and appears as an Annex to this report.

«The staff of the Ministerial Task Force at this time consisted of two persons.

The most important tasks which had to be solved immediately to get the project going were, among others:

- Establish a project organisation which could plan and administer the running of the Programme and various activities within it;
- Negotiate agreements and sign contracts with suppliers of both hardware and software;
- Negotiate agreements of co-operation with the teachers' organisations and institutions which were involved, or would be involved, in the programme (e.g. in connection with in-service training, activities aimed at development of competence, evaluation);
- Select a sample of experimental schools and project schools and sign agreements with the various school owners (communities and counties);
- Establish advisory bodies and contacts, with a view to the running of the project (e.g. the teachers' organisations and the various Ministerial Advisory Councils);
- Provide information and advice to the Ministry, and to interested external parties such as individual schools, school owners, hardware and software producers, etc;
- Establish and further develop a network of contacts with competent individuals and computer milieus which could give advice and assistance in running the Programme.

All of these were tasks which had to be done before the important part of the Action Programme could be started at all. On the other hand, the Task Force was confronted with an enor-

mous pressure of expectations. "Everybody wanted in, and wanted their share. Everbody wanted answers to their important questions, immediately".
Generally these were expectations which could have been realised when put to a well-staffed project organisation, with enough time to plan and complete the necessary preparations, and with ten times the money that the Task Force had at its disposal.»

Problems

The background paper highlights the major problems encountered by all those concerned with the Programme of Action, during the first phase of the programme, as follows:

«The first year of the implementation period presented a series of problems for all parties involved in the Programme of Action.

The White Paper, (St.meld No.39), was a very good starting point, in that it threw light upon, and partly clarified, a series of fundamental questions of both a pedagogical and political nature. It stated the aims, principles and priorities of the Programme. It was, however, not followed by any written strategies for the implementation of the Programme, nor any specific guidelines for preventing or solving the problems which would occur in an extensive and complicated Programme such as this.

The problems were mostly due to various conditions that hardly could be mastered under the given conditions. Time was lacking to solve most of the immediate and concrete problems because of the tight schedule. This was mostly due to a far too optimistic implementation plan. It was unrealistic to believe that a Programme of Action of such diversity could be followed through, and the intentions fulfilled within four years, without having clarified any detailed strategy and without having a thorough and more detailed plan for the practical implementation of the Programme in advance.

Added to this was the fact that the Ministerial Task Force was clearly very understaffed in relation to the many tasks it was confronting.

The following points raised difficulties in connection with the implementation of the Programme of Action.

- There was a gap between the basic intentions of the Programme and practical pedagogical ideas and guidelines for how to reach them. In addition, the economic resources were quite limited in relation to the many areas of action;
- The level of expertise available for training and qualifying the teachers participating in the experiment was insufficient;
- The schools selected for the experiment lacked the necessary competence for managing this kind of decentralised development;
- There was, at the start, a considerable shortage of suitable educational software - and little or no expertise for developing Norwegian software.

As a consequence of all this, the experimental period of four years already seemed, at the start, to be too short.»

Problems experienced by the experimental schools

«The experimental schools also experienced a great many challenges during this first phase of the Programme:

- Insufficient project plans and too little consideration of aims and means within the projects;
- In many cases there were individuals or smaller groups of teachers behind the ideas of the project, and not the whole school as had been intended. This reduced the obligation to the project;
- Insufficient competence in managing and administering development projects;
- Only a few of the teachers had any competence in the use of computer technology (here there is a difference between the teachers in vocational education and the teachers in general education and primary schools);
- Lack of economic resources for a sufficient training programme for the teachers and for the purchase of software and the necessary number of computers;
- Lack of support systems to cover the schools' need for assistance in carrying out development projects;
- Large delays in the delivery and installation of the computers;
- Lack of suitable educational software.

During the first phase of the Programme, many of the schools felt that they were left to themselves. They needed assistance in most of the areas connected with their experiments, but the Ministerial Task Force had insufficient capacity or time to meet this need. For many of the schools the consequence was that it took a long time before they could start running the projects they had planned.

Most of the schools had problems with their microcomputers at the beginning, and this delayed the experimental activity even further. What helped the schools through this period, which for some schools may be called a "crisis", was enthusiasm and motivation. In addition there were individuals at all the schools who worked far beyond what could reasonably be expected.»

Development of Competence

«One may divide the development of competence into several sub-areas. Separately, and together, they constitute very important and basic conditions for the implementation of the Programme, as well as the sub-goals of the Programme.

These main areas are:

- Knowledge of computer technology, and insight into the functions of computer technology in education, and the various areas where it can be used;
- Competence in the use of computers and the use of computer technology as a tool in the various subjects;
- Competence in the implementation and evaluation of experimental activities and development work;
- Competence in design and development of educational software.

Primarily this development of competence has taken place in the form of courses and seminars and by individual coaching. The courses have been arranged on a national, regional and local level, and for individual schools, either completely financed or partially financed through the Action Programme. This financial support has also been given to educational programmes at the Universities and Regional Colleges of various types, but particularly to Teachers' Colleges.

When referring to the development of competence, software development must be specifically mentioned. This has, for several reasons, been an area of top priority, since the start of the Programme in 1984. The main reason for this is obvious: if computer technology is to have any place in education, the schools must have sufficient educational software, of high professional and pedagogical quality. Another reason was the aim of producing Norwegian software. Throughout the past three years, importance has been attached to qualifying courses in software design and software development. The participants of these courses have been teachers, writers and representatives from publishing houses.

Approximately 400 people have received training and they have been recruited from all over the country. One course was aimed at training instructors in software development. They now constitute a national network of competent individuals that are called upond for in-service training of teachers and as advisors for those working in the field of software development.

As a direct consequence of the efforts directed towards this area, a series of projects have been started. At present there are more than twenty programs ready for pilot testing in the experimental schools, 90 are under production or at the contract phase.

When it comes to software, one must mention the purchase and adjustment of programming tools and standard programs, like Knowledgeman, CAD-CAM systems, NTH-prolog, etc. The use of these tools has been widely spread, due to a rather large number of introductory and further qualifying courses.»

What has been achieved

«In the experiment up till now (July 1987), it is possible to identify at least three main phases.

The Hardware Phase

For the schools the main tasks in this phase was to choose which microcomputer they wanted to use, purchase the hardware, install and learn how to use it.

The first phase was marked by late deliveries, frequent breakdowns and a large degree of discontentment within the schools.

Concerning the development of competence of the teachers, the intentions were to include the whole staff and give everybody a basic introduction. Even if there were great variations one might say that, generally, there was little experience with computer technology in the experimental schools. The brief introductory courses given were a start,

17

and there was really a lack of resources available for any more.

The Program Phase

This phase was actually simultaneous with the hardware phase. The focus of work of the Ministerial Task Force in this phase was to obtain and alter existing software, and to develop new Norwegian software.

To the schools, the situation in this phase was that there was little software obtainable. Mainly the choice was from standard programs, such as word processing and spreadsheets. There was little educational software, and almost nothing where the Norwegian language was used. In addition the schools had scant resources for purchasing additional software. To many of the schools this was a desperate and highly frustrating situation. They had started an experiment, but they considered they had little to base the experiment upon.

These two phases lasted for about one to two school years. It varied of course from school to school. During that very same period, development of competence was heavily stressed on all important areas stated by the Action Programme.

The Experimental Phase

Only after the necessary preparatory work on the areas of technology, software and the development of competence did the schools and the various participants involved in the experiment feel prepared to begin experimental activities outside what was already being done in the schools in the field of computer technology.

By now the Ministerial Task Force was fully staffed and they had a well-functioning network of consultants and advisors in different parts of the country and the development of competence was well underway in the various areas of high priority.

Thus, the situation today is that for many of the schools the planned experiment has been going on for the last school year only (1986/87), after almost two years of planning, replanning and necessary preparation. One must, however, point out that there are large individual differences between the schools and the various experiments and projects. Those schools who have projects in vocational training (especially the courses for trade and commerce, craft and industry), obtained a head start, since they had had a year-long experience of using computer technology in education. The fact that the actual experimental period has been relatively short, means that there are relatively few specific and documented results from the various experiments. An exception is vocational training and special education. Substantial experience has been gained from this model for implementing a programme of such complexity as the Action Programme.»

RESULTS

The decision to introduce the use of computers into Norwegian education and the action of the Task Force over

the last three years has led to a two-faced situation. On one hand, what has been achieved in a short time (experimental schools, teacher training, standards for hardware, development of software, etc.), is very impressive and represents a strong start for future developments.

On the other hand, considering the small number of teachers involved as compared to the total number of teachers and the scarcity of available software, what has been achieved is a small experiment which cannot, without serious risks of missing the aims and objectives (White Paper, St.meld. nr.39), be generalised right away to the whole Norwegian educational system (see II, The Next Phase).

Impressive results noted by the OECD Examiners' Group

As in many countries, the initial focus in Norway for school use of computers was on teaching computer science, or on a vaguely defined attempt at computer literacy for teachers and students. What the programme has achieved is a shift of emphasis to a more profitable direction: the use of the computer as a learning aid in all areas. This is a major consequence of the national programme.

The increased emphasis of viewing the computer as a teaching and/or learning tool has become accepted by a growing number of teachers. Furthermore, many more administrators are familiar with the possibilities. Increased exposure of this type is important for stimulating long-range changes in schools involving more use of computers.

The training of teachers has been recognised as the main problem to be solved for an effective use of computers in schools and great efforts have been made in that direction.

Attention has been given to the process of developing computer learning materials. Norway has advanced beyond the typical naive approach, common in many parts of the world, where the buying of hardware is considered as the main, if not the only, problem. This consideration and thought is important for extensive future developments.

The examiners noted with interest that there were instances where teachers had integrated the computer into a course, with the result that the curriculum had been extended and enhanced. Within the special education area, work was under way which contained an original idea of trying to develop hardware and software together in order to achieve a given objective. In the opinion of the examiners these activities should be encouraged in the future.

Both in the experimental schools and in other schools stimulated by the existence of the national project, increased numbers of computers have made their way into schools. While these numbers are still below those in a few other countries, Norway now has a significant and growing number of computers in schools.

Managerial experience has been

gained in the projects sponsored by the national Task Force. This experience will be important for future developments.

The national project has not solved all the problems associated with widespread introduction of computers in the schools, but it has made good and reasonable headway in that direction.

Norway's effort is impressive compared to many countries. At the beginning of this programme, Norway probably was lagging in this area, as compared to some other OECD countries. This is no longer the case.

20

II. THE FUTURE: PROPOSALS AND RECOMMENDATIONS

THE NEXT PHASE

The consensus amongst the OECD Examiners' Group is that the Norwegian government's intention of focusing on how microcomputers might enhance and improve teaching and learning strategies, as part of their national initiative, has achieved much. The country now has basic technical and educational experience of using microcomputers in educational institutions which allows Norway to move forward. This core of expertise is to be found amongst those working under the aegis of the Task Force and the «grass-roots» activities which have been developing alongside the national programme.

1. The second step towards a planned generalisation

To capitalise and build upon the work already accomplished and which is still taking place, it is now appropriate to plan a second step lasting between three and five years before undertaking the planned generalisation.

During this second step it is suggested:

- To extend the set of experimental schools * to a few hundred and install the hardware as necessary;
- To encourage creativity and the development of the necessary software;
- To train teachers of these schools and to revise the content of the teacher training curriculum by including more pedadogy related topics and less computer science topics;
- To develop a curriculum for those people who will train teachers in the use of computers in education, either during pre-service or in-service;
- To continue to invest in curriculum development;
- To establish an information network.

The next step should still be a controlled and nationally funded programme of activities, and should not attempt to encompass all the various facets of the Norwegian educational

* It should be noted, however, that there is disagreement on this point between Professor Alfred Bork and the other examiners. He would prefer to drop the entire notion of experimental schools in this second step, considering that presently this notion seems to upset many of the schools that have not been included in the programme.

system at this time. To attempt, at this stage, to introduce the use of computers into all schools could result in spurious activities which will not contribute to the long-term aims as stated in the White Paper (St.meld. nr.39).

At the conclusion of this second phase the concept of having a number of schools designated as experimental should be abandoned. A national programme could then be established where all schools in Norway would be on an equal basis, thus removing possible inequalities.

Even though there is a rather high level of equipment available within schools, there is a scarcity of educational software and knowledge concerning different pedagogical strategies. It cannot, therefore, be stressed too strongly that future activities should centre on investigating pedagogic strategies, developing curriculum-based software, providing teacher training courses (at all levels) and establishing an information network.

FUNDING AND TIME SCALE

2. The importance of adequate funding

The initial phase of the introduction of computers in education in Norway has already represented a high level of investment (NKr 100 million). The road chosen by the Norwegian authorities since 1983 is not the easy one but in the opinion of the OECD examiners a very realistic and promising one.

It is said in the White Paper «Computer teaching can mean a considerable broadening of the pupils' learning opportunities, but it can also mean a narrowing and passivisation» and very wisely since the beginning, the main emphasis and also the greatest investments have been made in teacher training and software development.

In the next phase, moving towards a totally national programme to introduce computers into schools, the main effort should again be on teacher training and educational software development and sufficient funding should be available to solve these two problems at the right level. The total amount should be adequate, so as to allow the next phase to reach the stated objectives, but the way the money is split between the various activities will be at least as important as the total amount allocated. It is, for instance, strongly recommended that funding should be for people and projects, rather than for schools.

3. Encourage Acquisition of Equipment

It may be necessary for some central funding to still be made available to assist schools with the purchase of computers and/or peripherals. The funding can be a percentage of the total cost, however, that percentage is related to the level of control the Ministry wishes to exert on the choice of the equipment. In some countries the government buys directly the equipment and gives it to the schools (100 per cent and total control), whereas in other countries the government pays a percentage of equipment costs, thereby gaining partial control.

The smaller the percentage, the more

influence is given to local vendors, which may become a problem, first because local schools may not be competent to make the right choice, and second because increasing the number of computer models increases the portability problem for software. Whatever the percentage, such funds do not necessarily have to be offered to individual schools, but could be passed to a regional or local administrative body for disbursement. In this way such funds could be used to meet the locally perceived needs of particular schools.

4. The Time Scale Should be Realistic

Development of effective use of computers in education is a long and involved process, taking many years. It is likely that we are still in the early stages of such development. It is essential to keep in mind that the process is a long and slow one. The OECD Examiners' Group was disturbed about the use of the word «quickly» to characterise the pace of this and future experiments, in several of the documents the examiners were given. A realistic view of the time scale is needed by all those concerned.

THE ORGANISATIONAL ISSUES

5. Establish a new Task Force or other central body

The development of the computer as an effective aid in education is still fragile. Although the potential is great, for all countries, the development needs special assistance at the national level if it is to be effective. Norway should continue such assistance.

It is also important, in the long run, to institutionalise educational endeavors, eventually moving them into the main stream. In Norway now this would appear to be primarily within the Advisory Councils, and in other similar groups within the relevant Ministries. The people the examiners met agreed, however, that these bodies do not, at present, have competence in computers; even the Council representatives who the examiners met agreed with this view. Therefore, the process of institutionalisation will require time.

A new Task Force or some other central body is therefore still necessary during this second phase. One of its important functions during the next few years should be to plan, in co-operation with the other components of the educational system, the eventual institutionalisation of the process of introducing computers into the Norwegian educational system. This will not be an easy process and will require many years.

As these recommendations suggest, the role of the proposed central body will not be the same as during the present phase, and will moreover change during this next phase.

THE CURRICULUM

6. Focus on Improving Education

The White Paper clearly states that it is the hope of the Norwegian government that the introduction of computers into education will result in improvements. For example:

«The overriding aim of the introduction of computer technology in the schools must be to place the school in a better position to provide support in the development of the individual pupil. The object of using the computer as a teaching aid must be to place pupils in an easier learning situation and at the same time free the teacher to devote more time to pupils who need extra help.» (p. 4).

«Understanding what learning entails is central in any educational development project. Experience can throw some light on how computer technology can more systematically help pupils to acquire control of the learning process itself.» (p. 22).

The OECD Examiners' Group strongly approves and agrees with these aims and believes that the focus of the entire effort, in the future, should be on improving education. It should be emphasized, to administrators, teachers, and government officials, that the issue is not just hardware, software and teacher training. The emphasis should be on increased student learning. The student should be at the centre of the work with computers in education. It is important for everyone involved to recognise that this is the major point of the effort to introduce computers into schools.

7. Solve Problems in Norwegian Education

«It is the government's opinion that Norway should be able to rank as one of the leaders in the development of advanced technology in the years ahead. In this connection, it will be important that the schools play a part in this development. The education of our children, youth and adults must be considered an important contribution towards advancing and guiding technological and social developments.» (p.5).

The government was concerned to avoid unfortunate side-effects from the introduction of computer technology, particularly:

«New and sharper divisions between pupils must be avoided. It is important to make sure that the pupils, irrespective of gender, receive teaching according to their interests, experience and intellectual capacity.»

The Examiners' Group found that this factor had been considered by those involved at national and local level, and found no evidence of new divisions having been created since the introduction of computer technology.

Access to equipment in the schools visited appeared to be on pupil demand, and although some institutions had placed equipment in computer rooms, these were open to pupils throughout the school day and complemented by additional computers placed at strategic accessible locations around the school, e.g. the library.

«Social interaction in the school should be carefully nurtured. It has become widely acknowledged that "every technology creates its own environment". Careful consideration should be given as to whether the introduction of computers adversely affects co-operation and comradeship between pupils and thus the instilling of ideas of equal-

ity and community spirit. Situations where those who are good with computers take charge of the technical equipment while the majority are admiring spectators are not acceptable.»

Pupils were seen by the examiners to be working in small groups using one keyboard, and at all the institutions visited pupils were encouraged to assist each other when using the computer. Those institutions which had invited parents and others from the local community into the school to be shown what was being done with computers were using the pupils as the tutors on these occasions. In one school pupils were found to be assisting with the management of the computer equipment, (computer monitors), and providing this task is spread across all pupils whatever their gender and abilities this should help to avoid the possibility of creating the «computer expert».

«New difficult learning situations should be avoided. It can be mentioned, for example, that reading from a display screen or from printouts can present difficulties where the quality is not good enough. Work with computers can also demand a degree of precision, for example in the use of codes, which is perhaps too demanding for a number of pupils. Enthusiastic reports of what children can achieve with the computer hardly tell us what all children can manage. The computer should be used to make concrete and visible what otherwise can be difficult to grasp, and also to avoid even more weight being laid upon theory in the school.»

Staff from the various institutions that the examiners met were aware of the problems some pupils might encounter when using computers, but it appeared that support from their peers and teaching staff was high and normally available.

«... the importance of the choice of teaching materials being varied so that there will be genuine opportunities of choice for teachers and pupils. Over employment of programs with mainly drill-type exercises should be avoided.»

Teachers indicated that the level of choice is still limited due to a lack of educational software. Provided future plans include a well-funded and diverse development programme of computer-based learning material, the problem should be alleviated in the future.

8. Place Greater Emphasis on Curriculum Development

In the experimental phase now being completed in Norway, much of the software produced is small bits and pieces of computer learning material, often only loosely related to the curriculum. This is not surprising in the early period; a similar emphasis on small programs with no close connection with the student curricula is common all over the world. But Norway should now begin to shift toward integrating the computer components with other aspects of the curriculum, and so move toward major development.

For computers to achieve maximum effectiveness with students, they must be used within the context of the standard learning environment. Most courses depend on existing curriculum materials, because few teachers have time for extensive curriculum development. Hence the software must be an integral part of courses, fitting in with and complementing the other available learning resources.

Developing computer material for a set of existing learning resources, such as textbooks, is better than developing completely unrelated pieces of software, but is not the best strategy for achieving maximum learning effectiveness. A better approach is to specify and to develop all the learning materials, computer-based, text-based and others, as part of the same production process. It is only then that the computer becomes a critical part of the learning material. Far too few courses have been developed in this way so far, in any part of the world.

Unfortunately this desirable strategy is not easy, and experience needs to be gained first in the use and potential of computers in the classroom. The White Paper refers to this potential change as follows:

«In time, experience gained from the teaching of computer studies and the use of computers in other subject teaching will provide a basis for changes in curriculum, partly because methodical assumptions will have changed and partly because new technology gives the opportunity for a new content.» (p. 21).

These curriculum efforts that invoke computers should address the major topics and subjects normally covered in the schools in Norway. Development of materials that has little to do with the standard curricula of the schools should be discouraged, or at least not supported.

9. Concentration in Sizeable Components of Courses

A corollary of the above recommendation is that effort should be directed to learning programs occupying a period of time, segments of courses or entire courses. A small piece of material, no matter how excellent, can make only a small impact on student learning. Single computer programs, therefore, can have only a limited impact.

Certain subjects lend themselves better than others to computer-based learning. So these should be developed in a coherent set spanning a sizeable part of the course.

There are interesting examples of this type already under way with young children. A coherent set of activities has been developed, spanning a time of weeks, or possibly even months. More projects of this type, where the software is part of a new pedagogical strategy, should be developed and used in schools. Additional experience is needed in developing such course components.

10. Develop Teacher Training Materials

As part of the development of each component of the curriculum, the necessary materials for training

teachers in the use of software should be developed along with the student materials. A promising direction is to develop interactive computer-based learning modules to complement other teacher training materials. New roles for teachers may be involved when using software, so special training may be needed.

11. Explore Alternate Pedagogical Strategies

Among the pedagogical strategies that have been implemented are: the tutorial strategy, including dialogs, where the computer is used to teach part of a subject; drill and practice; the use of databases as a resource; modelling and simulations, either in the guided discovery mode or in the insight development mode. None of these techniques is exclusive of the others and using a simple or a mixed strategy depends on the subject, the pedagogical aims, the time available, and the age range of students, etc. As with other aspects of computer-based learning, our knowledge is far from complete and therefore several directions should be pursued.

Whereas any classification includes an amount of arbitration, the various existing computer-based learning modules in all countries can be split into two main categories which represent two different approaches to the use of computers in education.

In one category the computer is used to teach a certain amount of knowledge, and in this case it is important for the software to include modules which are able to check the student's progress and offer help and assistance to those students with learning, problems related to the material, which should not contain racial, gender or any other bias. Some experts have even gone further by proposing the concept of mastery learning, whereby students stay with a given area, seeing a variety of new learning approaches, until they demonstrate full capabilities in the area. Pace may vary from student to student and mastery learning is presented as being possible for all students because of the highly interactive capabilities of the computer. It should however be emphasized that this kind of project is very ambitious, that the relevant software is very difficult to design and to implement and, depending on the subjects taught, the volume of the software has no upper limit and can easily reach a few hundred thousand instructions.

In the second category the user is expected to learn from the use of the computer, but the computer is not expected to teach anything. The teaching process, the checking of the student's progress, the assistance to those with learning problems and the presentation of a variety of learning approaches are left to the teacher. The software allows the user to ask questions, to undertake experiments, to explore the area of knowledge, to ask for exercises of different levels of difficulty, etc., and the user is expected to do so as various steps of a pedagogical strategy which has been defined by the teacher.

The computer-based learning modules of the second category are much easier to design and implement, mainly because each module is a single step in a pedagogical strategy, and not

a set of steps defining a complete pedagogical strategy as is the case for the first category. Moreover, the software modules are much shorter, firstly for the above reason and secondly because the computer asks no questions, therefore there is no need for the extra pieces of software devoted to the student's answer analysis.

In fact, as already stated, any classification is arbitrary and there exists a great number of computer-based learning modules which are close to one category or the other.

Generally speaking, experience has shown that any given pedagogical strategy is more or less efficient and easy to implement, depending on the subject to be taught and the objectives of the teacher, and as our knowledge is far from complete, all directions should be investigated.

12. Explore Alternate Production Strategies

A variety of developmental strategies and systems have demonstrated, in many countries, important capabilities for producing effective computer-based learning units. While many approaches can lead to useful material, different approaches may produce different types of material, all important in learning. Further, as with the aspects of computer-based learning, our knowledge in this area is far from complete. So several directions should be pursued in Norway.

So far the major development model in Norway is the «Grimstad» model, a Norwegian modification of the «market model» developed in Ontario. Other approaches will most certainly lead to interesting material important for learning, which would be difficult to attain with the Grimstad model. These approaches should be used.

13. Develop Distance Learning Courses for Schools

Distance learning involving computers and telecommunications could be an important component of the Norwegian educational system. Because of the existence of many small schools, and the remote scattered locations of many schools, distance learning should be explored.

There is little experience in designing computer-based curriculum material for distance learning. Norway could make a major contribution to world education in this area. New and innovative approaches are needed, rather than just the hardware allowing telecommunications. The problem is a difficult one; such courses often fail.

It should be kept in mind that for distance learning, as for education in general, computers do not replace anything. They are an add-on, allowing educational strategies and activities which are impossible without computers. What has been said under the recommendation 8 about the specification and development of all learning material, computer-based and text-based, as part of the same production process, remains true for distance learning, with the added constraint of the specificities of distance learning.

14. Stimulate International Projects

The cost of developing good computer-based learning units are sizeable and

there definitely exists a possibility to share these costs by participating in international development projects. In a country such as Norway, with, as yet, limited experience of developing educational software, participation in international projects could be a source of gaining a considerable amount of experience.

Co-operation in this area already exists between Nordic countries and it could be extended beyond, towards international projects, where teams can co-operate in real time in specifying, developing and implementing complete modules by co-operation through electronic mail.

In the White Paper, the Norwegian government referred to the expected «flood of cheap foreign educational software which can be of doubtful quality and which moreover is not suited to, or does not take into consideration, Norwegian culture or traditions.» (p. 3).

Foreign educational software has been investigated by some of the people the examiners met, and the majority was discarded as being unsuitable. This shows that there are specialists in Norway who are able to recognise whether a software module is suitable for Norwegian schools or not. In fact, in a common project, all parties involved will be able to influence the outcome, discard whatever they feel is inappropriate to their own country and still benefit from the end product or the part of the end product which is useable.

In such developments, areas where cultural differences are likely to be minor, such as science and mathematics, should receive the main emphasis. The development groups must be sensitive to possible cultural differences, and different pedagogical strategies which may exist within the participating countries. Learning materials might have approaches from several countries in the same programs, strengthening the learning process.

Versions can be developed in various languages for different countries. The programming strategies followed in development should allow the programs to be moved to other languages with little difficulty. Market possibilities might exist in countries beside those represented in the development project. In this way the costs of development could be made more reasonable.

We stress again that development of high-quality computer-based learning modules is difficult and very expensive. International co-operation could increase the competence of potential authors through participation in large projects and reduce these costs. This would be particularly important for a small country like Norway with its own languages.

SOFTWARE DEVELOPMENT INITIATIVES

This area of development should remain as a government-funded activity. All the staff involved in this activity need not be based at one central location provided such activities are centrally funded and strong direction from a central body is available (i.e. a

new Task Force or some other central body).

15. Create a National Software Centre

During the proposed next phase of the national programme it would, in the opinion of the examiners, be useful to create a National Software Centre with sub centres at key locations in Norway. Software development groups would be based in the centre(s) where there are a number of prerequisites, implying the following tasks:

- To gather international information, either in printed form or in software form, of the various results of ongoing research about the use of computers in education and make it available to Norwegian teachers;
- To publish, or encourage publication of, booklets in Norwegian on the various existing pedagogical strategies implemented in software (tutorial, drill and practice, simulation, microworlds, guided discovery in various disciplines, etc);
- To publish, or encourage publication of, booklets in Norwegian on the various existing strategies and techniques to develop educational software;
- To insist on the importance of developing software directly usable with the existing curricula, and on the importance of developing a coherent set of software inside a given discipline and for a given age level, rather than non-related bits and pieces;
- To act as a «club» where people interested in a given subject could contact each other (eventually through electronic mail or audio-conferences) in order to work together;
- To act as a «clearing-house» where all interested teachers could access a database to discover details of software that is available or under development, and a contact from whom further information is available.

Although the direction of software development groups should be undertaken by a central body, it must not be seen to be isolated from other curriculum development initiatives which are occurring within the Norwegian educational world and elsewhere. It will need to liaise with existing Norwegian subject curriculum development bodies and ensure that the widest possible flow of information exists between itself and other groups. The use of electronic mail will help to facilitate this flow of information, but it must be remembered that nothing can replace the bringing together of people for face-to-face discussions. For this reason it is recommended that those involved in the development of computer-based learning materials should be brought together on a regular basis, perhaps in local meetings (once a week), regional meetings (every 3 months) and national meetings (once a year). Travel, subsistence and accommodation expenses should be provided from national funds.

The final structure of the Centre(s) is not easy to define and depends on local circumstances. However, various possibilities exist. It could be an administrative structure inside the Ministry of Education localised in a single building or it could be a kind of informal structure with a small central staff (si-

milar to the present Task Force) co-ordinating regional and local centres where the greater part of the work would be done.

16. Decentralise the software creation activity

The establishment of the centre(s) should not preclude individual or small groups of teachers from participating in software development. The central body could prepare a one-page document with guidelines for a National Software Project, which teachers who wish to become involved in this area could use as a basis to design a project and then submit it for central funding. The Ministry might allocate a total number of off-duty hours (1 000 to 1 500 per month for the whole of Norway), which the central body could in turn allocate to individual teachers, or a team, with a maximum of 25 per cent to 50 per cent off-duty time per teacher.

A partnership between technical staff (e.g. system analysts, programmers, technicians, etc.), teaching staff and staff responsible for disseminating information should be formed within these software development groups.

Any effort to develop sizeable amounts of high quality educational software needs a professional approach, and a design or development group. Several funded groups based throughout Norway for software development are essential. Therefore, these groups should be in well-chosen locations, and should be provided with good working conditions. They should attempt to attract the best possible people.

The reason for which several development groups are strongly suggested is that we do not yet know enough in this area, and therefore diversity is needed. Each group should be partially free to pursue its own directions, following the general framework suggested in this report and building on the work accomplished so far. These groups should not be isolated, but should involve all educational components in Norway, including the Universities, The Advisory Councils and the Regional Directors.

Software development groups do not need to be comprised of just those teachers who have experience of using computers. Teachers who have experience of curriculum development should also be seconded to software development groups. In this way Norway will be able to establish curriculum development teams involved in designing and producing computer-based learning materials.

The central body should set guidelines, objectives and working methods along the lines of these recommendations.

17. Encourage International Co-operation

Consideration should be given to establishing one or more such group(s) for international co-operation. The group(s) would engage in developmental projects involving Norway and other countries, typically with support from all the countries involved. Materials produced would be available in several languages. The desirability of international co-operation has been mentioned previously within this report.

As already mentioned, software groups should be encouraged to pursue the development of materials which will investigate different teaching and learning strategies. A study of world-wide activities in this area would be worthwhile, in order to avoid the «reinventing the wheel» syndrome.

18. Avoid Duplication of Effort

It is necessary to maintain a nationally-formed direction in the development of computer-based learning materials to ensure that materials developed are directly linked to, and useable inside, existing curricula and to avoid duplication of effort. A national body would need to pull together activities in this area in a coherent and progressive manner, thereby avoiding the development of small individual pieces of software which have little relevance to the curriculum.

The development and enhancement of tools to assist with producing computer-based curriculum materials should be part of at least one of the development groups.

19. Train Future Software Authors

Courses for teachers interested in becoming involved in developing computer-related materials should be continued but broadened. The adoption of the Grimstad model was relevant at the time, and it has been interesting to note that the restrictiveness of working with only one model has already been recognised and the original model has been adapted and changed. There is a great variety of pedagogical strategies available for educational software and their relative efficiencies or fitness to various aspects of teaching are still a subject of research. It is therefore recommended to view all these different strategies as something which will always be under review and likely to change as knowledge of the potential of computers in education develops.

Norway now has a small core of teachers and lecturers who are experienced in using computers in the classroom. Some of them have attended software development courses, and it is these people who should initially form the core of the software development teams and undertake the training of future software authors. Arrangements need to be made to release them from their institutions full-time or part-time for the duration of a project.

The linking of pedagogical software development with in-service training courses should be encouraged. Teachers attending courses should feel that they are able to participate in present and future developments. This exchange of ideas between those producing computer-based materials and their eventual customers will prove worthwhile.

The production of text materials associated with software packages should occur side by side with the development of software. Documentation and associated multi-media materials should not be undertaken as an afterthought once the software has been developed, but should be seen as an integral part of the whole development of computer-based learning material.

20. Define methods for disseminating information on software

It is important that a method of disseminating information about software development is established. It will be necessary to keep all interested parties, government, national and local educational administrative bodies, schools, etc. aware of products in the pipeline and products completed.

The products of the software development initiative need to be made available, and it will be necessary to use a dissemination vehicle, whether controlled by the government or by the established publishing houses, which will outlive this proposed next phase of development. It is perhaps pertinent to point out that it is unlikely that developmental costs can be recouped from the sale of software within the educational market.

TEACHER TRAINING INITIATIVES

21. Overcoming Teacher Training problems

The Task Force in co-operation with others, has instigated three types of courses: basic awareness level, subject related, and software development. The current programmes have already seen the training of teachers as an important issue. But the programme needs to be extended to more teachers in Norway.

Experiences in many parts of the world show that much of the training of teachers about the use of interactive learning possibilities is ineffective. Only a very few locations do it well, mostly because of the presence of outstanding individuals in these locations. Hence national and local programmes elsewhere do not offer an adequate guide to Norway.

Inspection of programmes elsewhere shows a progression in such courses. First we often see many simple modules teaching programming to teachers, usually in ineffective languages such as BASIC. Norway is beyond this stage. A second stage of such training focuses on computer literacy, emphasizing general tools, such as word processors. Many of the Norwegian training programmes seem to fit into this category. A third stage, seldom done adequately, has a pedagogical emphasis, stressing the use of computers in all subjects. The difficulties with this desirable third stage stems from our lack of knowledge, and from our lack of sufficient adequate software to furnish examples of a variety of types of usage in a specific academic area.

The use of practising teachers, who have actually used computers in their teaching effectively, as lecturers on such courses can be useful in generating discussion within the groups as to the advantages and disadvantages of using a particular strategy or package, and the perceived changes within the classroom that have occurred, or might occur.

Teachers who have already attended courses will require a further training programme to be inititated for them as developments in software and hardware occur.

Training teachers about computers in education is difficult. So further work in designing such courses is needed.

This should include curricular materials directed specifically to the teacher. A national group, in conjunction with the relevant Advisory Council(s) should be assigned this problem. A special national effort is needed to generate adequate courses for teachers. Computer-based learning material may be useful in this regard.

The management of the use of computers in schools should become an element of all teacher training courses. This is a problem area that teaching staff encounter once they start to use computers on a regular basis and should be seen as a problem to be solved eventually by the institution, but with some guidance from those who have been using computers for some time.

22. Involving the Advisory Council(s)

The Advisory Council(s) responsible for this area should be encouraged to become involved in the design and implementation of teacher training courses relating to the use of computers, both pre-service and in-service. During discussions with the examiners, the representatives of the Advisory Council(s) appeared to be willing to participate in this activity, but felt that at present they lacked the necessary knowledge of what the content should be.

This situation needs to be remedied as soon as possible. Representatives from the Advisory Councils should be encouraged to attend courses under the existing programme of activity, with a view to becoming part of future teacher training initiatives during the next proposed phase.

Plans should be developed to decentralise the implementation of teacher training courses to a regional or local level. The design of such courses should remain the responsibility of the relevant national bodies, but the design should allow for flexibility at local level to include items which are considered to be relevant to that particular locality.

23. Necessity of including computers in pre-service training

Teacher training colleges should include as part of all pre-service training courses an element which gives future teachers the opportunity to understand and investigate the way computers are being used, and might be used, in the school.

It will be necessary, possibly on a national level, to undertake the training of the teacher training college lecturers (all subjects), and to provide an ongoing programme of courses to ensure that the latest developments are incorporated in their courses. This area could also become part of the remit of the central body.

DISSEMINATION OF INFORMATION

24. Develop National and International Communication

The OECD Examiners' Group frequently encountered the attitude that information about the use of computers in the Norwegian educational system was not adequately disseminated. This

may not be the case, but the perception alone demands a response.

25. Disseminate written information

During the next proposed phase it is important to allocate sufficient budget and personnel whose task it will be to disseminate information on all activities concerning the use of computers in education. Information should be systematically distributed to the whole school system, government officials and relevant organisations within commerce and industry.

Large reports should be avoided because they are generally not read by teachers. Leaflets with short and significant news on what has been accomplished recently, what is occuring and what is planned should be issued often and regularly. Such information should always mention groups and individual people with their contact address, and details of the activity or product. Moreover various channels for dissemination should be investigated to ensure that all teachers receive the information.

No nation has a monopoly of effective strategies of using computers to assist learning. Important work is going on in many countries and should be known in Norway. Hence support should be available for travel abroad. Those receiving funds for this purpose should report to others in Norway.

26. Disseminate via electronic networks

Telecommunications between teachers and educational administrators can be important in a large sparsely-settled country. Modern strategies that reduce communications costs should be investigated in establishing this network.

The development of a centralised database containing details of software available, software under development, names and addresses of active institutions and individuals and details of national and local courses and conferences, should be considered. Access to such a database should be via the telephone network, although hard copy printouts need to be made available to those unable to access electronically.

27. Create a National Association of Teachers for Computers in Education

The creation of a National Association of Teachers for Computers in Education should be encouraged. It would be a «professional» body, representing people who have daily practical experience of computers in education. The Association would offer advice to the Ministry and school authorities when they are faced with technical problems in this field, and would also fulfil the following role:

- Enthusiastic people could meet each other and exchange ideas and experiences;
- Sub groups could be formed to study particular problems and technological innovations;
- By publication of a Bulletin where teachers can publish articles, a nationwide link would be created between teachers from different places in the country. The Bulletin would be the place where teachers can tell

about their daily practice with computers, where they can discuss their problems and make suggestions, etc;
- The Association would increase interest in the pedagogical use of computers and could greatly influence the use of home computers through appropriate actions;
- The Association could organise regional conferences where teachers could discuss their personal experiences of using computers in the classroom and any problems;
- The Association should organise each year in a different place a National Conference with a «Call for Papers» to all Norwegian teachers and should publish the proceedings of the Conference to allow teachers unable to participate to obtain the relevant information;
- Finally, the Association could play an important role in assisting with the dissemination of information.

Such an organisation is normally run by a group of elected members and the finances are normally provided by registration fees of the members and the profits made by selling reports and proceedings. It will require, however, some assistance to get started: an initial grant for printing registration bulletins, production of the first issues of a newsletter, support for teachers to attend meetings, etc. The central body should be encouraged to assist with the establishment of a national association, particularly in the early days. This assistance will most probably be in the areas of financial support, advice on proposed activities, establishing contacts within Norway and abroad who might be interested in joining, offering to speak at meetings, etc.

EQUIPMENT ISSUES

In the early days, the Norwegian project decided that it was desirable to focus on certain computers for schools. Should the equipment decisions now be broadened to include additional computers? The answer to this question cannot be provided by the examiners in a report such as this. The issue of whether or not education needs to use a variety of computers is one which is under discussion in many countries and a decision is generally reached based on the national context.

Generally speaking education, in any country, is still a small component of the computer market. Both the machines and the development of tool-like software is determined by other markets. This situation may well change in the future, but not quickly.

Some schools want to select computers based on their own needs. They should be warned that the fastest and cheapest equipment is not necessarily the most desirable at any given moment and that software portability, adherence to international standards, graphic compatibility etc. are fundamental arguments.

Allowing greater choice in equipment is however not inconsistent with establishing standards or guidelines for schools. Such guidelines should be established every year or two, taking into account the evolution of computers. This should be consistent with the

equipment available in the general market. Such standards should be considered by schools in choosing equipment.

A reasonable standard today might be as follows:

- 16- or 32- bit processor;
- At least 512K RAM;
- Diskette of at least 700K (except in networks with file servers);
- 400 by 640 minimum graphic resolution;
- At least four colours (more preferred);
- Operating system: DOS, UNIX or Macintosh.

Such standards and guidelines should be revised every year or two, taking into account the evolution of computers and attempting to remain upwardly compatible.

RESEARCH AND EVALUATION DIRECTIONS

Many of the recommendations made so far within this report are in fact subjects for research. In many countries, however, research into the pedagogical uses of computers has little status and brings low rewards in universities and academic circles. This leads to a small number of people, who are not necessarily the most appropriate, in that area. If we wish to achieve progress it is necessary to change the state of affairs by recognising the value of this type of research. It will be necessary to alter university structures in order for research in this area to begin. This is a prerequesite for defining a successful policy for the educational uses of computers in education. It should be done during the proposed next phase to prepare for the planned generalisation.

One component of educational research on computers should be directed to the problems particularly important for Norway. The size of the country, its small population, the many remote areas and cold climate present special problems. New modes of school organisation, and new modes of teacher training, may assist with these problems. Research may suggest new approaches to be followed.

Evaluation, in pedagogical term, of the use of computers is an open problem and is the subject of current research.

Appendix:

LIST OF PARTICIPANTS IN THE MEETINGS ORGANISED FOR THE EXAMINERS' VISIT

Saturday, 29th August 1987

Marit Granheim	Consultant, Ministry of Church & Education
Håkon Bjørnes	Director General
Arvid Staupe	Director, Task Force
Harald Bekken	Deputy Minister of Education

Sunday, 30th August 1987

Arvid Staupe	Director, Task Force
Kristin Myhre Nielsen	Consultant, Task Force
Berna Varaas	Head of Deptartment, Task Force
Arne Solstad	Consultant, Task Force

Monday, 31st August 1987

Jan Wibe	Consultant, Task Force

Huseby School:

Odlaug Brastad	Ed Second Master
Per Egil Toldnes	Adviser
Gustav Bernhardt	Project Leader
Paal Berg	Project Group Member
Per Myhre	Project Group Member

Representatives from Trondheim University:

Jørgen Løvseth	Leader of Comp Advisory Comm
Terje Rydland	Scientific Officer
Jan Ole Waagen	Leader of Centre for CAL at Technical University

Representative from Trondheim Technical College:

Geir Maribu	College Lecturer

Representatives from Sør-Trøndelag county:

Roar Slåttsveen	Head of the county school authorities, upper secondary level
Terje Storvik	Computer Consultant

Representatives from county school authorities, primary and lower secondary levels:

Bodil Skjånes Dugstad	Head of the county school authorities, primary and lower secondary level
Helen Bargel	Computer Consultant

Stjørdal Upper Secondary School:

Jon Eidsvik	Headmaster
Oddmund Brandsæter	Project Group Member
Svein Grande	Project Group Member
Leif Martin Hokstad	Project Group Member
Kjell Åge Nilsen	Project Group Member
Britt Leirfall	Project Group Member

Tuesday 1st September 1987

Representatives from Tromsø area:

Jan Forshaug	Computer consultant
Rolf Espenes	Lecturer Narvik Technical College
Lars Roar Langseth	University of Tromsø
Trond Schjefstad	Tromsø Teacher Training College
Knut Steen Henriksen	Consultant, Special Education

Nordreisa Upper Secondary School:

Gunnar Solvang	Headmaster
Harald Johansen	Project Leader
Svein Arne Rasmussen	Project operations leader
Magne Pedersen	Mechanics Teacher & Program Designer
Olav Olsen	Teacher
Rolf Bakkeslett	Mechanics Teacher
Anna Marie Killi	Home Economics Teacher
Asbjørn Pedersen	Project group member from Honningsvåg Upper Secondary School

Inger Staubo	Leader of Nordreisa Upper Secondary School Committee
Nils Thomas Utsi	Sami Council on Education

Wednesday, 2nd September 1987

Representatives from Stord College of Education:

Harald Haugen	Senior scientific officer
Lars Vavik	Lecturer

Representative from Rommetveit School:

Jostein Tvedte	Teacher and Project Member

Representative from University of Bergen:

Magne Myrtveit	Dept of Informatics

Representatives from Hardware Suppliers:

Einar Flydal	Compis Scandis International
Dag Steinsli	Compris Scandis International
Lars Monrad Krohn	Tiki
Rolf Kristiansen	IBM
Helge Bolneset	IBM

Task Force:

Mette Ramberg	Consultant

Others:

Anders Isnes	Department of Science, Oslo University
Nils Garli	National College of Teachers of Commerce
Svein Erik Knudsen	Spes. Prod A/S
Gunnar Gjone	Oslo Teacher College
Stefan Anderson	Sweden

Thursday, 3rd September 1987

Ms Kirsti Kolle Grøndahl	Minister of Education
Kristin Hille Valla	Chairman - National Advisory Council for Upper Secondary Education

Non-programme participants:

Edvard Befring	The Norwegian Postgraduate College of Special Education

Marit Holm	The Norwegian Postgraduate College of Special Education
Steinar Jocki	Finnmark local school authority
Tor Martin Ødegård	Deputy superintendant of Oslo school authority
Anne Lise Høstmark Tarrou	National College of Vocational Teacher Training
Egil Frøyland	National College of Vocational Teacher Training
Wilfred Wasenden	National College of Vocational Teacher Training
Kjell Askeland	University of Stockholm

Special Education:

Hans Tangerud	Consultant, Former Head of Department, Task Force
Steinar Såkvitne	Headmaster, Jeløy Special School
Eirin Brænde	Project Learder, Blindernveien Special School
Arnfinn Johansen	Consultant, Task Force

Friday, 4th September 1987

Dagfinn Høybråthen	Deputy Minister of Education until 1986
Håkon Bjørnes	Director General (Upper secondary)
Oddvar Vormeland	Director General (Primary and lower secondary)

Advisory Councils:

Olav Svartdal	National Advisory Council for Teacher Education
Toralf Tveiten	National Advisory Council for Primary and Lower Secondary School
Jan Petter Strømsheim	National Advisory Council for Primary and Lower Secondary School

Unions:
Knut Bråtane
Hans Groven
Per Arne Sæther
Marit Fredheim
Ebbe Jorde
Margit Nordsveen
Karsten Hansen

Ulf Vasstrøm	Nordic Council of Ministers
Dagfinn Føllesdal	Government Council for Information Technology
Arne Lie	Norwegian Confederation of Employers

Saturday, 5th September 1987

Representatives from IMTEC:

Per Dalin	Director
Knut Stranden	Consultant
Tor Bergli	Consultant

Extra Session:

Lars Vavik	Stord College of Education
Magne Myrtveit	Senior Consultant - Programming ACOS A/S
Pål I Davidsen	Assistant Professor, University of Bergen
José J Gonzales	Agder College of Engineers

ANNEX:

«COMPUTER TECHNOLOGY IN SCHOOLS: THE NORWEGIAN PROGRAMME OF ACTION»

November 1987

Revised background paper
prepared for the OECD Examiners' Group

TABLE OF CONTENTS

1. The period prior to the Programme of Action – and the background for the Programme of Action 45

2. Establishment to the Ministerial Task Force 49

3. Development of competence – the strategy of the Ministerial Task Force for implementing the Programme of Action 50

4. A description of the various stages of the Programme of Action 51

5. Expectations of the programme of Action 55

6. Problems during the first phase of the Programme 56

7. The school experiments under the Programme of Action 57

8. Development of software and computer equipment 59

9. What has been successfull – and what could have been done differently .. 64

10. Carrying on the activities under the Programme of Action 68

11. Necessary clarifications in the time to come 69

1. THE PERIOD PRIOR TO THE PROGRAMME OF ACTION AND THE BACKGROUND FOR THE PROGRAMME

The period prior to the Programme of Action is described as a time when unbelievably many things happened in the field of computer technology. It gained terrain in an increasing number of areas in industry and the business life, as well as in an increasing number of other areas in society.

With a few exceptions, the efforts in the sector of computer technology in the schools were concentrated on skills-training; especially in vocational education. A great many schools offered computer technology as an optional subject. But the school, as a whole, was very much outside what was happening in the field of computer technology.

Due to this situation, the educational system was put under pressure. Groups of parents, industry and commerce, politicians and various institutions in society all represented a pressure to incorporate computer technology and make it a part of everyday life in school.

The teachers' organisations were also of course aware of the importance of computer technology and watched closely from the beginning, but they were uncertain what to do, and therefore reluctant. Thus we see that the school system was confronted with an external as well as an internal demand to do something.

There were some communities already planning small scale experiments with computer technology, especially as an optional subject in the compulsory school. The Ministry for Church and Education, the National Advisory Councils and other institutions were asked for advice and recommendations regarding choice of computers and purchase of hardware and software. But due to lack of systematic and valid experiences, advice and recommendations were hard to get. This resulted in the preparation of a White Paper to the Parliament, where the principles and valid guidelines for a Programme of Action were laid out (St.meld. no 39) and where an extensive experiment with the use of computer technology in schools was recommended.

This White Paper is very important, since it forms the basis for a way of thinking as far as computer technology

in schools is concerned. It gives a broad survey of possible areas where computer technology may come into use, and what areas of use may be relevant in the future. It brings forward actual and fundamental questions with regard to hardware and software.

It also strongly stresses the importance of a broad and varied development of competence in the field, and especially so in teacher education and the qualifying of those teachers already in school.

The Programme concentrated on the following main areas concerning the use of computer technology in schools:

- Computer technology in Vocational Training - with the aim to improve the education - and make it more up to date. This includes cooperation with local trade and industry.
- Computer technology in special education - both as a tool and a remedy to reduce or overcome handicaps - and as a means to prevent new handicaps emerging.
- Computer technology as an aid/tool in various subjects. This includes both subjects where computer technology already is in use, and subjects where computer technology has no tradition. This includes the development of new educational software of high standards.
- Computer literacy - including personal skills in the use of computer technology for everybody in school, at least in compulsory education.

These components of the Programme may have considerable consequences for a series of conditions in school, such as teaching methods, the curriculum, the relations between teacher and student and the relation between students. In the long run it may also have effects on the traditional teacher-role and the school as an organization.

In the Programme the following four main areas have been given priority:

- Experimental activities in selected schools, both experimental schools (involving all the teachers and pupils) and project schools, the latter with small scale experiments limited to one or a few subjects and including a smaller number of teachers and students.
- Development and testing of educational software and special programmes, and the acquisition of commercial software.
- Establishing cooperation between different types of schools and between the school and the various computer milieus at the colleges and universities.
- The development of a national network of resource centres and resource persons representing various relevant professions to give the educational system the necessary support in developing the necessary competence.

In addition to the general aim of the school system, we find the following goals stated for the activities under the Programme of Action:

- To create the necessary conditions for teaching computer studies to prevent the emergence of new class divisions.
- To develop the educational system's own resources of expertise by creating conditions for development work and research based on initiative generated in schools and specialist centres.

- To involve individuals from all disciplines in trial teaching and a debate concerning the use of computer technology in the school.
- To stimulate the development of qualifications in all branches of the school system, as for example guidance, steering bodies and specialist advice.
- To organize collaboration across the boundaries of different kinds of schools and different educational levels to exploit existing knowledge and experience to the fullest possible extent.
- To stimulate extensive collaboration between education on all levels and with trade and industry.
- To develop further collaboration between home and school by concrete cooperational projects within computer teaching.
- To stimulate experiments in the use of computer technology in special education, and the collection, systematisation and dissemination of information on experience in this area.
- To seek better ways of learning with the aid of computer technology.

The premises for these goals in the project were:

a. New dividing lines between the students must be prevented.
b. The social harmony in school must be taken care of.
c. One must avoid the occurance of new kinds of teaching problems.
d. The teaching material must be varied and of such a quality that all the students benefit from it.

The White Paper was presented in Parliament in June 1984. After a long and engaged debate, the Parliament agreed on a Programme of Action for experimental activity with computer technology in schools. The debate in Parliament and the resolution to start a four-year period of experimentation is interesting for several reasons.

Primarily because the resolution that this debate lead to, partly explains both the design and development of the experiment - and partly explains some of the problems related to the start and some of the problems along the way.

The Programme of Action was the first national experiment that included various types of schools and a wide range of subjects since the National Coucil for Innovation in Education was dissolved.

This immediately posed the question of how the Programme should be organized, managed and administered. Four alternative arrangements were discussed:

a. The experiment could be managed and administered by the Ministry itself.
b. A special project organization (Task Force) could be established directly under the Ministry.
c. The administration of the experiment could be decentralized to various regions and administered with consistancy from the universities and regional colleges (especially the Teachers' Colleges).
d. The experiment as a whole could be undertaken by a qualified institution outside the public administration.

Even though there was general agree-

47

ment among the various political parties as to the principles and the idealogical basis for the Programme of Action, there was some debate in Parliament on certain points. The opposition maintained that:

1) The funding should be increased.
2) There ought to be a larger number of experimental schools.

The discussion also concerned the advisability of hiring IMTEC to evaluate the experimental activity. Many maintained that public funds should be used to increase competence in the public institutions.

The Parliament agreed to the idea of establishing a special project organization attached directly to the Ministry, and the necessary funds for establishing the Task Force were arranged. The Task Force should start its work immediately - and the four-year period of experimentation should run from the start of the school year 1984/85.

As a result of the debate, the IMTEC foundation received the contract to evaluate the Programme.

Although there were some minor differences of opinion, the debate in Parliament showed a large political agreement on a series of questions.

a. The schools had to join in and become part of the general development in industry and in society in general, where computer technology takes an increasingly central position. The school, reaching everybody, must be given tasks in the field of computer technology which counteract the establishment of new partitions in society. In the future, the school will also have an important function in the development of the country's general competence in computer technology. The school system as a whole must therefore be updated in order to contribute to this development. In line with this it was pointed out that the Programme of Action must be organized and followed through in such a way that differences in economical conditions do not count when it comes to who will benefit from the Programme, and thus contribute to variations between different parts of the country. It must not be organized in a way that may cause inequality of opportunities between students on a socio-economic basis.
b. In line with both the principle of equality and the intentions that the Programme of Action should be a part of the development of the total computer competence of the nation, the importance of including selected schools of various kinds and other relevant institutions in the Programme was pointed out during the debate. The Programme of Action should function as a «spearhead», and the schools directly involved should function as pilot-schools, where one could gain varied experiences which could be communicated to the school-system as a whole.

This last argument constitutes part of the background for the Parliament's wish for a short period of experimentation. The computer technology should be introduced into the school system in general and be a part of the schools' everyday life.

c. In the debate it was also heavily stressed that neither the activities under the Programme of Action nor the general introduction of computer technology in schools in any way must lead to a disturbance of the equality between sexes, which is a principal aim in the Norwegian school system.

d. An important political objective for the Norwegian school system is to avoid creating new class distinctions. In addition to what is mentioned under C, this involves giving equal opportunities independent of income, residence, social background, physical or mental ability etc.

e. The Parliament also stated that Norwegian language and Norwegian culture had to be given special attention.

A general and uncritical introduction of computer tecnology in the schools and society could lead to problems for a small culture like the Norwegian, since both the computer language and most of the available software is in English or other foreign languages. The importance of developing Norwegian software was therefore heavily stressed by Parliament.

f. Of the potential areas where computer technology can be put to use in the schools, the computer technology as a tool in special education and as an aid for the handicapped are stressed as particularily important areas to give priority.

g. For the above mentioned to be possible, it would be necessary that the Programme of Action made a point of stressing a general development of competence. This was especially true when it came to the teachers, both those already working in the schools and those to be trained.

h. The ministerial strategy was approved through limiting the number of school-computers to two types.

When it comes to the implementation of the Programme of Action, there is another condition which is important, because it influenced the planning of the various experiments, and has had consequences for the design and development of the experiment as a whole. In time, the upstarting of the Programme of Action concurred with the implementation of a new model for development projects and innovations in the school-system. The basic principles of this model, which was reported to the Parliament in another White Paper, is the decentralization of initiative. The responsibility for school development is up to the individual school and/or the individual school-owner. This too is connected with the dissolving of the National Council for Innovation in Education - and the winding up of the highly centralized model for experimentation and development work in schools. According to the new model, the schools should as far as possible manage on their own.

2. THE ESTABLISHMENT OF THE MINISTERIAL TASK FORCE

As stated earlier the Parliament gave the management and administration of the Programme of Action great con-

49

sideration. It ended with full support of the idea of establishing a Ministerial Task Force. This debate was continued elsewhere, especially in the National Advisory Councils and in the school administrations on different levels. In the beginning there was also a slight disagreement over the model decided upon.

The Ministry decided to establish the «Data Secretariat» as a special Task Force within the Ministry. From the Ministry's point of view there were several reasons for this. Primarily, the reason was that the Programme of Action for computer technology in schools had such high priority that the Ministry itself wished to take the initiative and establish a general policy that was in line with the aims and intentions of the Programme of Action.

Secondly, one of the basic intentions was that the Programme of Action should be followed through as a whole, and as an integrated and coordinated development project that included all subjects, most grade-levels, all types of schools and various geographic regions. At the start of the Programme there was no administrative body outside the Ministry which could cover all these areas and integrate the various activities.

It was also seen as important to have short lines of command, making quick decisions possible. It was also judged important to have an organization that secured quick feedback of information to the Ministry, making it possible at every stage to know how things were developing and what experience was gained.

Another important element was to build up and secure the further development of a computer expertise internally in the Ministry, which could function as a national resource centre for implementing data technology in the school system. For the Ministry it would, in the years to come, be very important to have the necessary expertise - both as to the following through of the activities under Programme of Action and with regard to advisory duties towards the schools in general.

An important element was for instance the need for an executive body which could develop national competence in the area of software development, coordinate the purchase of software, and further coordinate and administer the development and production of Norwegian software. This was seen as a necessity because of the lack of quantity and the quality variations in the existing software and the scarce resources available.

3. *DEVELOPMENT OF COMPETENCE - THE STRATEGY OF THE MINISTERIAL TASK FORCE FOR IMPLEMENTING THE PROGRAMME OF ACTION*

The basic element in the Task Force's strategy for implementing the Programme has been, and is, to direct the efforts towards the development of competence. And here we talk of development of competence on very broad terms. We do not talk of a competence which solely focuses on knowledge about computer technology and skills in the use of computers, nor of a devel-

opment of competence which solely benefits those primarily included in the school experiment. We talk of development of a competence which is directed towards the long-term aims of the Programme and its basic intentions. Short term, this strategy involves more qualified experiments and an increased competence for those involved in the Programme of Action. Long term, this development of competence will, if it does succeed, benefit the entire educational system, and help increase the total competence of the nation in the field of computer technology for educational purposes.

One may divide the development of competence into several subareas. Seperately, and together, they constitute very important and basic conditions for the implementation of the Programme, as well as the sub-goals in the Programme.

These main areas are:

- Competence in computer technology, and insight into the functions of computer technology in education, its various functions and the various areas where it can be used.
- Competence in the implementation and evaluation of experimental activities and development work.
- Competence in design and development of educational software.
- Competence in the use of computers and the use of computer technology as a tool in the various subjects.

Primarily this development of competence has taken place through courses, seminars and by individual couching. The courses have been arranged on a national, regional and local level and for the individual schools, and either completely financed or partially financed through the Programme of Action.

The development of competence which has been going on, has to a high degree been projects of cooperation between the Ministerial Task Force and competent individuals, resource groups from various computer milieus or organizations representing special competence. When talking of development of competence, the development of software must be mentioned specially. This has, for several reasons, been an area of top-priority since the start of the Programme in 1984.

The main reason for this is obvious. If the computer technology should have any function in education, the schools need sufficient educational software, both of professional and pedagogical quality. Another reason was the intention to produce Norwegian software. Throughout the three years that have passed, much importance has been attached to qualifying through courses in software-design and software-development.

4. A DESCRIPTION OF THE VARIOUS STAGES OF THE PROGRAMME OF ACTION

- Tasks and challenges during the first phase

The Parliament decided to accept the Programme of Action in June 1984, and the preparation for implementation had to start immediately. For the participat-

ing schools the start was set to the beginning of the school year 1984/85, that is to say in August 1984. This meant that the Ministerial Task Force was confronted with a series of tasks which had to be done simultaneously and problems that had to be solved immediately - and with little time to lose.

On the other hand, in the schools and in the school administrations, as well as for those with an interest in computer technology in school, expectations were high as to what the Programme should lead to.

The staff at the Ministerial Task Force at this time consisted of only two persons. They were recruited from the group which prepared the White Paper no. 39.

The first phase had to concentrate on preparatory work and information. The basis of the Programme and the strategy for much of the following development was laid out during this phase.

Prior to establishing the Ministerial Task Force, the Ministry had made a technical specification of demands for computers for both primary and secondary school. These specifications were based on pedagogical demands. The specifications formed the basis for a request for offers on computers to be used in the school experiments. In March 1984, contracts were signed for delivery of the Tiki and Scandis computers.

Preparations for selecting experimental schools also started relatively early, and prior to the Parliament's discussion of the White Paper. The schools were informed of the Programme of Action and were invited to participate in the experiment by the way of a memo, dated March 22, 1983 (F-35/84).

Parallel to selecting the first experimental schools, negotiations were made with the Teachers' Unions concerning their participation in the Programme of Action. A Contact group was then established, mainly for discussion and exchange of information. The following institutions and organisations are represented in the contact group:

* National Advisory Council for Primary and Lower Secondary Education,
* National Advisory Council for Upper Secondary Education,
* National Advisory Council for Teachers' Education,
* National Advisory Council for Vocational Education in Industry.
* The Ministry for Church and Education,
* The Ministry for Culture and Science,
* The Teachers' Unions (7) and
* The Central Organization for the Norwegian Municipalities.

Negotiations were also held with the Teachers' Unions on terms for the teachers' participation in the experimental activities. Further, a committee for coordinating the activities under the Programme of Action was established. The committee has representatives from the Ministerial Task Force and various departments in the Ministry and the National Adivisory Councils.

As stated earlier, in this phase the energy was concentrated on infor-

mation activities and preparation for the experimental period. Below some of the main activities in this period are listed.

In the Spring of 1984, a first initiative was taken to stimulate to cooperation on a regional level. 5 regional workshops were arranged, in which the regional school administrations in each county were represented. The Ministry and the National Advisory Councils were also represented. The two-way information concentrated on what was already going on, and the existing plans both on a central level and in the various counties. The assumption was, that this should be the basis for organizing regional coordinated activity, based on cooperation between the regional school administrations, the municipalities, the colleges and the computer milieus, as the White Paper No. 39 (1983/84) proposes. The suggestion for such a regional organization met with so much resistance that it was withdrawn and the Ministry has not taken any further initiative in this matter.

In August 1984, a conference was arranged for school administrations from various levels in the school system. The aim was to inform about the use of computer technology in schools, and give some insight into evaluation and school development. The course had close to 100 participants.

This conference was followed up by 9 regional courses (Autumn 1984 and Spring 1985), where schools were invited. The IMTEC-foundation was responsible for carrying out all of these courses.

In addition to this, staff-members from the Ministerial Task Force attended a series of regional and local arrangements to inform about the Programme of Action.

The basis for the later development of specific educational software was also made in this first phase of the Programme of Action. The first workshop in software-development was arranged at Grimstad in July 1984.

The work of entering into agreements on prices and terms of delivery for commercial software was very time-consuming in the first phase. This work lead to agreements for the integrated software-package Knowledge manager (K-mann), the design and construction programmes VersaCad, AutoCad, PS-INTAPT and PSDRAW, as well as NTH-prologue and IDIGS/GKS. An important reason for choosing these products, was that the suppliers committed themselves to translating the software into Norwegian.

During this first phase, the project-organization administering the Programme of Action was developed.

The tasks during the first period were mostly problems that had to be solved before the Programme of Action could be started at all. On the other hand the Task Force was confronted with an enormous pressure of expectations. «Everybody wanted in, and to have their share. Everybody wanted answers to their important questions, immediately.» Generally these were expectations which could have been realistic when put to a well-staffed project organisation, with enough time to plan and make the necessary preparations, and with enough money.

The greatest difficulty was, however, that one within the school-system did not have enough competence to see that development takes time, and to manage to put it in a realistic perspective.

Phase 2

The period from the Autumn 1985 to the turn of the year 1986-87 was a phase where a series of experiments and projects were launched. Most of the experimental schools started for real then, and agreements were signed for a series of projects involving software development. A substantial part of the projects in software development were initiated during the courses in software development held by the Ministry.

At the end of the period, it was possible to make priorities among the many specific development projects for which plans had been worked out. An example is MI-2000 (Mechanical Industry towards year 2000). Longterm projects, such as standards for description and dataformats for demographic data, agreements on access to various databases, and experiments with computer communication and simulations were initiated. The first of a series workshops were also started, aimed at special education, the first of these concerning word processing and alternative keyboards.

An important task in this period was to establish contacts with various computer milieus and resource persons who could participate in the future development.

Phase 3

1987 is signified by starting to yield result form the experimental and development work. These results came in the form of experiences form the experimental schools and software ready for testing. This has made it possible to stress subject-related courses in particular, utilizing computer technology in various subjects. The necessity of such courses has been strongly stressed, especially by the experimental schools.

While the information to external parties previously had to be quite general, one has now been able to inform about more concrete experiences and give examples. As this was meant to be the last year of th Programme of Action, particular stress was made on going public with results and experiences, and many of the staff members of the Ministerial Task Force have administered and participated in courses and seminars. Besides the subject-related courses, workshops have been arranged for administrators and politicians in every county, and special stress has been made on information on computer technology in upper secondary school and especially vocational training. One is also working on a series of reports on the experimental activity.

In 1985 substantial grants were given to the regional school administrations for arranging introductional courses for teachers. This amount was reduced in 1986. In 1987, the resources available have all been used for the Ministry's own activities, in accordance with the requirements of the experimental schools.

All phases

Throughout all the phases, the Ministerial Task Force has placed means at the disposal of the National Advisory Counsil for Primary schools and Lower Secondary Education. There has been a close cooperation in building a councelling network administered by the regional school directors. Support is also given to the National Adivisory Council for Upper Secondary Education, for arranging courses for teachers in the upper secondary school.

It is difficult to give a complete survey of the work of the Ministerial Task Force, but below we have tried to give a brief summary of the tasks that to some degree have been relevant all through the period.

- Experimental activity in schools; including Primary schools, Lower and Upper Secondary schools, special education, agricultural schools, and in Sami areas. The work involves evaluating applications, courses and workshops, visits, information and providing economic support.
- Hardware and software development-projects, setting up forms of agreement, evaluating applications, negotiations, followup, payments, routines for copying, software production and distribution prior to testing in the field etc.
- Development of a councelling network for software development.
- Agreements with persons and institutions on implementing software.
- Negotiations for access to various databases.
- Negotiations with the Norwegian Telecom for various services.
- Contact with the suppliers of hardware and software.
- Contact and negotiations abroad on access to software.
- Course activity, workshops, seminars, etc.
- International cooperation in the field of computer technology.

A backing from individuals and institutions with an interest in the Programme must also be mentioned. A network was developed, which could serve as a support-system in carrying out the various parts of the Programme.

5. EXPECTATIONS OF THE PROGRAMME OF ACTION

As has been mentioned previously, there were large expectations of the Programme of Action, and many of these were far from realistic.

From the politicians there was a clear expectation that the Programme of Action should lead to an updating of the schools, making them more able to meet the «new age». It was also expected that computer technology should modernize the vocational training with regard to the demands from commerce and industry. Certain expectations were also tied to the use of computer technology in special education. There were also clear expectations that one, through the Programme of Action, would gain a higher level of competence in the teaching profession, as well as in the nation as a whole.

The Ministry hoped, during the Programme period, to build up qualified

experience among teachers, managers and policy makers; making it possible to develop suitable directions and guidelines for introducing computer technology in the school system in general at a later date.

For the Advisory Councils, it was very important that through systematic experimentation, experiences would be gained which the Councils could build upon and use in their own activities. They also hoped that the Programme of Action could contribute to a development of educational software of high quality.

In the schools there was a general expectation that the activity under the Programme of Action would give the schools a valuable tool for use in the various subjects. Also there was a clear expectation of extensive inservice training which could increase the general competence of the teachers, as well as a more specific competence in the use of computer technology. Further the schools hoped that the work under the Programme of Action would lead to an increased amount of educational software, and a strong effort in development and production of Norwegian software, also in subjects where no such software existed.

6. *PROBLEMS DURING THE FIRST PHASE OF THE PROGRAMME*

The first year of the implementation period presented a series of problems for all parties involved in the Programme of Action.

The White Paper (St.meld. No 39) was a very good starting point due to the fact that it threw a light upon and partly clarified a series of fundamental questions of both pedagogical and political nature. It stated the aims, principles and priorities of the Programme. It was, however, not followed by any written strategies for the implementation of the Programme, nor specific guidelines for preventing or solving the problems which had to come in such an extensive and complicated programme as this.

The problems faced were mostly due to various conditions that hardly could be mastered under the given conditions. Most of the immediate and concrete problems had their background in a too tight schedule and lack of time. This was mostly due to a far too optimistic implementation plan. It was unrealistic to believe that the Programme of Action, with the extent it had, could be followed through and the intentions fullfilled within four years, without having clarified any detailed strategy or without having a thorough and more detailed plan for the practical implementation of the Programme in advance.

To this came the fact that the Ministerial Task Force clearly was understaffed in relation to the many tasks it was confronting.

As pointed out above, the White Paper gave very few, if any, particular guidelines for the implementation of the Programme. The many tasks to be done and the extreme time pressure gave limited possibilities for the Ministerial Task Force to follow up its own strategy and give sufficient information about it.

It was of great importance that the Programme got a strong backing from the top in the political management in the Ministry. This lead to perfect cooperation and very quick decisions when needed.

7. THE SCHOOL EXPERIMENTS UNDER THE PROGRAMME OF ACTION

The experimental schools also experienced many challenges during this first phase of the Programme.

The situation upon starting the experimental activity can be described as follows:

- Insufficient project plans and too little attention paid to aims and means in the project.
- In many cases there were individuals or smaller groups of teachers behind the ideas for projects, and not the school as a whole as the intention was. This caused less obligation towards the project.
- Not sufficient competence in managing and administering developement projects.
- Only a few of the teachers had any competence in the use of computer technology (here there is a difference between the teachers in vocational education and the teachers in general education and primary schools).
- Lack of economic resources for sufficient training of the teachers and for buying software and the necessary number of computers.
- Lack of support-systems to cover the schools' need for assistance in carrying out development projects.
- Large delays in the delivery and installment of one of the recommended computers.
- Little access to suitable educational software.

Lack of necessary information and sufficient contact with those instances responsible for the Programme.

During the first phase of the Programme, many of the schools felt that they were left to themselves. They had a great need for assistance in most of the areas connected to their experiments. For many of the schools the consequence was that it took a long time before they could start the projects they had planned, and which had been agreed upon by the Government. According to the policy of locally managed experiments, the school should as far as possible manage on their own.

Technical problems with the computers and in getting the software functioning.

Most of the schools had problems with their computers in the start. What helped the schools through this period, which for some schools may be called a «crisis», was enthusiasm and motivation. At all the schools there were individuals who worked far beyond normal working hours.

Stages of the experimental activity

In the experimental activity up till now (July 1987), it is possible to differ between at least three main phases.

1. *The hardware phase*

During this phase the technological basis was laid for the experiments under the Programme of Action. In this phase, the Ministerial Task Force, based on recommendations from the committee evaluating potential computers for use in schools, had to obtain offers and recommend hardware for the participating schools. Afterwards the work of adjusting the hardware to use in schools and finding technological solutions fitted for the many and varied needs in vocational training and special education started. One very particular task in this phase, was to make one of the machines fitted for the Sami alphabet.

For the schools the main tasks in this phase were to choose which machine they wanted to use, purchase the hardware, install it, make it work and learn how to use it.

All of this meant various problems. When it comes to the two recommended machines, they have somewhat different specifications, making them unequally fitted for various purposes. The problem for some of the schools was that they were rather uncertain as to what purpose they were going to use the computers for. As previously mentioned, several of the project plans were vague and somewhat incomplete, and they did not have the necessary background information for selecting computers. In several schools there was no particular expertise to call upon.

The first phase was marked by late deliveries, frequent breakdowns for one of the computers, and a large degree of discontent in the schools.

Concerning the development of competence among the teachers, the intentions were to include the whole staff and give everyone a basic introduction. Even if there were great variations - one might say that generally there was little experience with computer technology in the experimental schools. The brief introduction-courses given were a start, and there was really too litte available resources for any more.

2. *The programme phase*

This phase was actually simultanuous with the «hardware-phase».

The focus of the work of the Ministerial Task Force in this phase is mentioned previously; to obtain and adjust existing software, and to develop new Norwegian software.

For the schools, the situation in this phase was that there was little software obtainable. Mainly the choice was standard programmes, such as wordprocessing and spread-sheets.

There was little educational software, and almost nothing where the Norwegian language was in use. In addition, the schools had very limited resources for purchasing additional software. For many of the schools this was a desperate and highly frustrating situation. They had started an experiment, but they felt that they did not have very much to base the experiment upon.

These two phases lasted for about 1 - 2 years, with variations from school to school. During that very same period, development of competence was heavily stressed on all areas of importance stated by the Programme of Action.

3. *The experimental phase*

Only after the most necessary preparatory work concerning technology, software and development of competence, the schools and the various participants involved in the experiment were prepared for experimental activities outside what was already being done in the schools in the field of computer technology.

By now the Ministerial Task Force was fully staffed and they had a well functioning network of consultants and advisors in different parts of the country, and the competence-development was well underway in the various areas of high priority.

In connection with the experimental activities in the schools, one must mention one particular aspect of the competencedevelopment. As previously mentioned, many of the experimental schools had relatively little experience and routine when dealing with locally managed development-work of such a complicated nature as this, where the aim of development of the school itself complicated it even further. Quite early one acknowledged that the schools were in need of assistance so that they better could run their own experiments. For this reason, courses were arranged for the schools, and they were advised on how to make their project plans.

Thus, the situation today is that for many of the schools, the planned experiment has been going on for the last school-year only (1986/87), after almost two years of planning, replanning and necessary preparation. One must, however, point out that there are large individual differences between the schools and the various experiments and projects. Those schools who have projects in vocational training (especially the education for trade and commerce and for craft and industry), got a headstart, since they had former experience with computer technology in education. The fact that the actual experimental period has been relatively short, means that there are relatively few specific and documented results from the various experiments. Exceptions are the vocational training and special education. One has gained much and substantial experience from this model for implementing a programme of such a complexity as the Programme of Action.

8. DEVELOPMENT OF SOFTWARE AND COMPUTER EQUIPMENT

Description of the work

In the White Paper no. 39 (1983-84), it is stated that one of the most important tasks in the Programme of Action will be to provide access to sufficient software for the schools. This has thus been a high priority task for the Ministerial Task Force. In particular, one has aimed at:

- development of competence
- development of a regional model for software development with support and back-up from the central administration.
- providing a method for software development, enabling the ordinary teacher to participate in software development, without any previous education in computer technology.
- promote the use of the Norwegian

language in software being used in the classroom.
- provide software which is easy to use.
- make the software development more efficient, to reduce time and cost of development.
- active participation in international cooperation.

Previously we had little or no experience in Norway in producing software for the schools. From those that have come further, like Scotland, Ontario in Canada, Houston and Minnesota in USA, we knew that it was a very extensive job to get the production of software started. In the places mentioned above, the authorities have aimed at special *units* for software production and distribution.

In Norway the aim is using the school system as a whole in this extensive task, and a regional model with central management has been established.

A regional model of development

A nationwide network is built for development and adjustment of software. This network consists of 8 milieus built around colleges/universities that give teacher education and/or offer education in computer technology in the regions. These milieus are crucial when it comes to programming and adjustment of equipment. There are also instructors and advisors in software design in several of these milieus, which total 20 nationwide. In these milieus there are approximately 40 programmers/ technically professionals involved in the work. These persons work part-time. In addition it has been necessary to enter into agreements with individuals/companies for development or transferring the software to other computer configurations.

Development of competence

In the White Paper No. 39 (1983-84) it is pointed out that there are differing views whether the best creators of educational software are teachers with a substantial additional education in computer technology, or teams of professional computer science personell and teachers together. The White Paper states that one should gain experiences with both models. During the first phase, it was particularly aimed at bringing pedagogues and computer experts together in teams. Since it is, and still is expected to be, a scantiness of persons covering both the pedagogical and the technical profession - it was necessary to work out a model where pedagogues and programmers cooperate in a way so as to give pedagogues as much freedom as possible to design the programme according to the role it will have in teaching/learning in the classroom.

The development projects are split into phases. First, the pedagogues specify the programme, then the idea is transferred to a computer programme by computer professionals and programmers. Then the programme is tested in the experimental schools. Throughout all the above mentioned phases, the advisors from the existing network follow up the development. In practice there is close cooperation between the pedagogues behind the idea of the programme and the computer professionals.

The Ministerial Task Force is in close contact with all the projects and can watch the progress closely. This has proven very important and necessary.

In connection with software production, it has been necessary to develop competence almost from scratch. The aim has been:

1. To start the development of Norwegian, educational software, by making the teachers themselves define the needs of the school.
2. To make a contribution to the development of competence in general. This goes for teachers and advisors, as well as programmers.
3. To make specifications for programming tools and start the development of prototyping tools and programming tools for the development of educational software to be used in schools.

The work on software development started in the summer 1984, with the courses in software design. The contents and structure of the course was designed in cooperation with persons from several Norwegian professional milieus and the Ministry. Expertise was brought in from areas like pedagogic, informatics, perception, graphical design, communication, information and school development. The course is based on a system development model adjusted to pedagogical thinking. *The method is based on an open model of learning, contrary to programmed teaching.*

The method has been continuously developed since it was introduced, with regards to new perspectives on pedagogical and tecnical solutions. The method used in software design is based on a model proposed by Les Green, Ontario Canada, who was a key-person developing and carrying out the first courses.

Since 1984, Norway has also, actively, participated in the building of similar development programmes on a Nordic basis, specially so through the Nordic Council of Ministers.

Courses and seminars for programmers and instructors/advisors

With a view to professional and organization coordination, it is necessary to provide the advisor, and programmers with systematic additional training and up-dating.

The software-development process

The development of software is done in five stages:

1. the idea/design stage,
2. the programming stage,
3. the testing stage
4. the corrective stage,
5. the distribution stage.

So far, the software developed through funding from the Ministry is in one or other of the first four stages.

Methods for obtaining software

One has so far mostly supported ideas for software from teachers, instead of initiating softwaredevelopment projects centrally. This has been natural for several reasons:

61

- The teachers attending the software-design courses have had a lot of ideas. During the courses, these were put in concrete terms. They have found areas where the computer can contribute to better teaching.
- An early analysis showed that there were very few concrete suggestions as to what kind of software should be developed. At the same time there was a great demand for educational software.
- One has wanted to support local initiative. This has been made possible by spreading the softwaredevelopment projects all over the country.
- It was expected that the software-development work would create a better general understanding of the possible uses of computers in schools.
- There were no milieus which in advance seemed to have special knowledge as to the use of computers in schools.

Under the Programme of Action, vocational education and special education have been given priority. Of the current projects, approx. 30 % concern vocational education, and approx. 25 % special education. Among the general subjects, there are projects in social science, natural science, handicrafts, Norwegian and foreign languages.

The two first-mentioned subjects have the most projects. We would also like to mention that within subjects such as music and handicrafts, many good ideas have come up.

The software which is being developed covers a wide area. The first programmes which were developed are not necessarily given highest priority, nor do they cover the most important needs of the schools. In many cases, projects have been given support primarily because they represented technological challenges which could be of use in later projects. One has also wanted to encourage development in subjects which traditionally have had little attention as far as software is concerned. For the same reason, designcourses have been arranged within such subjects.

The process so far has lead to competence and awareness of yet other strategies for finding suitable software-projects. At the moment, development groups are being set up within various subjects. These groups will, among other things, analyse and define requirements for software and initiate software development. So far, such groups have been set up for foreign languages, mathematics and special education. Through these first groups, one hopes to gain experience with this model.

Preparatory work is being done in order to analyse the requirements for software. This is a Nordic cooperational project.

It will be necessary to proceed with various models for how to obtain ideas for software-development. Commissioned development of software, based on analysis and specifications, is one possible model. It is, however, important that requirements are not defined solely on the basis of the existing software. New thinking and ideas must be stimulated and encouraged. The experimental phase is still going on, and variation in the type of soft-

ware and software-development is therefore important.

Evaluation of software

An important part of the process of developing software is the evaluation of the software when used in the classroom. Norwegian teachers have so far had little experience with the use of computers as a teaching-aid, and therefore a guide to software-evaluation has been made (the «Egg-report»).

The evaluation of the software is done in the experimental schools. Other schools have also had the possibility to take part in this process, as the software ready for testing has been sent to the local school authorities and the teacher training colleges.

Through the Nordic Council of Ministers, a form for a standardized description of software has been made. This form is the basis for a software-catalogue which soon will be available to the schools.

The evaluation of software must be done on several levels. One must, among other things, take into account user-friendliness (each screen-picture and the course of the programme), learning effects, social consequences, and unintentional positive or negative side-effects. The evaluation which has taken place in the schools so far, has been important for the process in each school, as well as for the Task Force. The evaluation of software is, however, complex and extensive, and it is therefore necessary to involve the various expertise, not only the various school-subjects. A plan for this is being prepared.

Increasing the efficiency of software development

In the computer milieus there is a lot of talk about new programme development tools. The use of these tools have made it possible to reduce both production time and costs, in addition to obtaining better functioning programmes with less bugs.

Therefore, it was natural to look for such possibilities when developing educational software too. When analysing the software development projects, a need was found for specific toolprogrammes and the development of such programmes started relatively early. We may mention two of the programmes: «Mosaikk» and «Sim-Sim». These have distinct potentials for use outside school, both in Norway and in other countries.

There is now a distinct need for continuous development of new products or improvements of the products we already have, to increase the efficiency of software development. In particular there is a need to reduce costs when adjusting programmes for use in various kinds of computers. To-day's experience is that adjusting software to two school computers increases the development cost per programme considerably.

The tool-programme models have not been accessible or possible to buy from abroad. The experiences with the Norwegian software mentioned above indicate that there is a considerable market for such products.

Blanket orders on software

Coherent to the Programme ot Ac-

tion, stress is put to gain favourable agreements for commercial software being used in the industry. This is regarded as especially important for vocational education with its specific need to use software currently being used in the industry.

Prior to entering into agreements with the individual suppliers, they are publicly invited to submit tenders. The Ministry has also entered into an agreement with the Scottish Ministry of Education on access to existing software. The Ministerial Task Force is also in contact with other countries for similar arrangements.

Favourably, blanket orders made by the central authorities have, for certain software products, formed a basis for a rational development of educational packages with the same software products as a basis. Such agreements are also important means to getting hardware and software of high quality and at a favourable price.

The Ministry has not during the experimental activity deemed it necessary to manage or control the schools' procurement of software, other than the indirect coordination in the fact that products made available by the central authorities are offered at exceptionally good terms.

Computer equipment

A series of computer development projects have been started, especially connected to vocational education and special education.

In these areas the schools have been depending on complicated (and expensive) computer equipment. The Ministerial Task Force has developed equipment and made software available, suitable for these schools. At the same time, learning the use of the equipment being used in the industry is made possible.

One example here is the management and training in management techniques for tooling machinery (CAD/CAM). In this field a pedagogical training programme is developed, where the students may choose between various degrees of difficulty, from a simple form of dialogue to code programming according to current standards in the industry.

Publishing houses

The Ministry feels that software development is a task for the publishing houses as well. In this connection there has been a series of meetings between the Ministry and representatives from publishing houses and the union of professional writers.

9. WHAT HAS BEEN SUCCESSFUL - AND WHAT COULD HAVE BEEN DONE DIFFERENTLY

When one is to look at what has been successful, and at the same time point out what could have been done differently, this must be based on the given situation. One must take into consideration the existing conditions and the very limited time available for the Programme of Action.

There are some areas where there is a general agreement that the Programme of Action has already given positive results. This is most obvious

when it comes to development of competence, development of software, building of networks and in gaining experience through systematic evaluations.

1. *Development of competence.*

The attempts made have strongly contributed to an increase in competence in the area of applied data-technology in the Norwegian school-system. This is not only true for the schools involved in the experiment, but also the school-system in general. It is especially important that the Regional Colleges, particularly the Teachers' Colleges, have joined in. This will possibly have long term effects.

The competence-development concerns areas like use of programming tools, and of course design/development of software and use of computer technology as a tool in various subjects. An increase in competence has also taken place in the fields of special education and in the vocational education of various kinds.

2. *Development of educational software.*

Even though the development of Norwegian software only is at its start, it is well underway. A basic model is developed for design of programmes, giving a starting point for the further development. Through various qualifying courses, one has created a corps of program-designers and several decentralized milieus for development of software.

One objection concerns the fact that one, during the Programme of Action, has committed oneself mainly to one particular model for programme design, while there are other models that might be just as useful.

The involvement of publishing houses and softwarehours in the development of more sophisticated educational software has been less then expected. In spite of some efforts to stimulate their interest, particulary the publishing houses are to a large extent awaiting the further development before going into the field.

3. *Building of networks.*

Partly due to conscious attempts, and partly as a effect of the efforts for competence-development, a network to-day exists of competent resource-persons who are able to participate in the ongoing implementation of computer technology in schools.

One kind of network which also should be mentioned, is that which is established as a result of Scandinavian and international contact and cooperation in this field. This is especially true on the software side. As a consequence hereof, the public schoolsystem is part of what happens in the field of computer technology and the experiences made in other parts of the world.

4. *Systematic collection of information through an evaluation programme.*

The Programme of Action for computer technology is probably the first experiment of this size where a continuous, systematic evaluation is planned for and executed by an independent institution.

For this part of the Programme, the Ministry has a contract with the IM-

65

TEC-foundation, which has followed the development of the Programme since 1984, both at school-level and on system-level.

The process evaluation which is now taking place, serves at least four purposes:

- to give the experimental schools feedback and basis for eventual corrections on the way.
- to give the Ministerial Task Force information on how the Programme is running, and what seems to be central problems in the Programme of Action and the school experiments.
- to get information/data which may serve as a basis for decision-making in the Ministry and in the Parliament.
- to give the schools outside the Programme of Action a part in the experiences made, so that they may take them into consideration when they eventually plan and start their own projects.

So far, mainly the experimental schools have gained from the evaluation. For the participating schools, the evaluation has meant increased consciousness of what they really want to do and a basis for further planning.

5. *Increased debate on the place of computer technology in schools and in education.*

The Programme has to a greater extent clarified the relationship between the possibilities and limitations of the computer technology, and a more realistic view of what may be expected in the time to come. In particular the lack of available educational software has lead to a larger extent of realism.

Another result of the debate on the Programme is increased interest in computer technology as a tool in the various subjects. This also concerns subjects where computer technology has no history. A third result is the termination of the period when computers in schools normally meant «computer programming».

When it comes to things that could have been done differently, we have previously mentioned some failing assumptions which lead to problems making the start of the experimental activity difficult. Most of the problems may be said to have their origin in a short experimental period and a very strict timeschedule, which lead to a strain on everything that had to be done and for everyone involved in the Programme. Almost everything had to be done simultaneously, by the same persons, and there were few possibilities of clarifying the problems in advance.

It may now seems that the experimental period already at the starting point should have been prolonged with at least one year and the experimental activities in the selected schools postponed to the second year of the Programme. This would have given all the parties involved time and possibilities for the necessary preparations, like negotiations, getting the computers and equipment functioning, development of competence and staffing the Ministerial Task Force with the necessary number of staff members and the necessary competence. The schools would also

have had a more time, with less frustration, if they had known they had one year at their disposal to prepare both the project and themselves.

It should have been possible to put more effort into distribution of information. This goes for information on both policy and strategy, as well as the plans for what had to be done, and how to do it. This would have reduced the uncertainty of what was going to happen and thereby helped limit the frustrations during the first phase.

6. *Other effects of the Programme of Action*

Perhaps the most important effect of the Programme of Action is that it has very strongly contributed to establishing a Norwegian milieu for computer technology in schools. This concerns both the persons and groups directly connected to the Ministerial Task Force, and more independent persons and groups spread all over the country, who are engaged in programme development and in-service training. At both levels these milieus have contributed to diffusion of knowledge and skills to schools outside the Programme of Action.

The Programme of Action has also lead to an increased interest and activity in teachers' education. Several of the Teachers' Colleges now offer education giving competence in computer technology. Several of the Teachers' Colleges are involved in the development work going on under the Programme of Action and some of the schools have their own projects, independent of the Programme. This is especially true in the colleges that educate teachers for special education and vocational education.

An important effect of the Programme of Action, is that in the Norwegian school as a whole, there is an increasing interest and awareness of the necessity of doing something in the field of computer technology. Indirectly this may be attributed to the Programme of Action, since the Programme in itself tells that this is of great importance and an area of high priority in the time to come. Directly, some of the diffusion may be taken back to the basic work done by the Ministerial Task Force, such as agreements and purchase of hardware and software, development of competence etc.

One last effect to be mentioned, is that the introduction of computer technology in many ways may seem to have shaken up the school as an organization. This concerns perhaps the experimental schools and the project schools in particular. A new medium has made its way into school, which, long term, will involve even further demands for changes. This concerns both the curriculum, the instruction, the learning activities, and the traditional student- and teacher-roles. In particular the demand for change will be strengthened as enough educational software is developed to be able to use computer technology as a tool in the various subjects. For the students this means a much more active role in the process of learning, and for the teachers this will mean a far greater stress on various advisory functions.

10. CARRYING ON THE ACTIVITIES UNDER THE PROGRAMME OF ACTION

There seems to be a broad consensus that the work started under the Programme of Action must be continued. This goes for both the activities in the experimental schools, which in 1987 just has started for real, the development of software and a further competence development. All these areas are important factors in order to reach the long term aims and intentions of the Programme of Action. If this is to be done in a systematic way and with valid basis in the experiences gained till now, it seems close at hand to prolong both the experimental period and the function of the Ministerial Task Force.

Continuing the evaluation-study must also be considered. From now on, it will be possible to obtain valuable information at school-level and student-level to tell something about what is happening in the classrooms. This information is necessary, both to be able to evaluate what has been gained till now, and as a basis for planning the future development and priorites.

These considerations are based on a strong and widespread conviction that computer technology will have a very central place in education in the time to come. It will be of great importancee in all types of schools and in many subjects. The computers will, in particular, become of practical importance as educational software is developed, which increases the possibility for use of computer technology as a tool in the various subjects.

One fundamental question here, is how the carrying on of the work initiated through the Programme of Action should be organized in the future. The following ideas of organization are based on what we now know of the needs of the schools - and what needs there probably will be in the future. It seems obvious that when the experimental period is over, there will still be a need for an organization which to a certain degree has superior responsibility for coordinating the important elements in implementing computer technology in the school, such as hardware, software and the continuous development of competence. There seems to be a need for a kind of national resourcecentre with broad professional competence in a series of different areas.

In addition to a national resourcecentre, it seems necessary to aim at building up competence on several levels in the school system, both in the central school-administration and on the regional and local levels.

The Advisory Councils must be updated, so that they have the necessary competence to assist the schools with advice and help. This concerns both the day-to-day running of computer-assisted education and potential new experiments in schools and in-service training. They must also have the necessary competence to succeed in integrating computer technology into the curriculum and the guidelines for the various subjects.

On the regional levels, the regional school administrations must be updated, so that they can meet the needs

in their region. This is especially important when it comes to further development of competence and experimental activities.

On the local level, it might be necessary to establish local resource-centres. Many of the municipalities have already established socalled «pedagogical centres». In sparcely populated areas, this could be organized by cooperation between several communities.

It will also be necessary to aim at further development of the Teachers' Colleges, so that the next generation of teachers may have computer technology as part of their basic education. The Teachers' Colleges may also function as additional regional resourcecentres. Further education in the use of computer technology and development work in schools will be important tasks for the Teachers' Colleges.

If this complex system of resource- and competence-centres is to work and really serve the schools, it is necessary to clarify the various areas of responsibility and an extended cooperation that makes it possible to coordinate the resources.

11. NECESSARY CLARIFICATIONS IN THE TIME TO COME

If the basic aims and intentions of the Programme of Action shall be reached, there seem to be several fundamental questions that call for a clarification as soon as possible.

The most important ones seem to be:

- clarification of a policy and further policy development
- economy and financing
- a strategy for further development

Short term this is of importance for the planning and management of the remaining period of the Programme. Long term the clarification of these questions could give the basis for planning the further development in the field of computer technology in schools, i.e. the transition from experiment to normal situation.

The Government has put forward a parliamentary bill proposing NKr. 12 million for 1988 to establish a new national development centre for computer technology in education. The development centre is to have 12 full-time posts, and will among other things have the coordinating responsibility for the development of hardware and software. The above-mentioned comes in addition to the proposal of 12,5 mill. NOK to the Task Force, which will be dissolved August 1, 1988. The budget proposal also includes considerable additional increases as regards computer technology in school. The Government is of the opinion that the experimental activity should continue, and that the need for in-service training of teachers will increase. The National Advisory Councils will play an important role in this connection, and the Ministry therefore proposes a total of 5 new full-time posts for the three councils.

The budget for the programme for computer technology in vocational education has been increased from NKr. 17 million to NKr. 35,6 million. The total budget for computer technology in education is from Nkr. 41,7 million in 1987, to Nkr. 72,6 million in 1988. The number of full-time posts has been pro-

posed increased from 11 to 21. The Ministry is in addition working on a White Paper concerning computer technology in schools. The White Paper will report on the experimental period so far, as well as outline a proposal for the future strategy.

Clarification of the strategy for further development and actions

Through the Programme of Action, which in itself is a strategy, the process of implementation has started. Now it seems to be time to consciously think out how to take the process further, and how to organize the transition to a normal situation, where computer technology not only is a part of an experiment, but a part of everyday life of the school. How should this be done? How fast? To what extent? And who has the responsibility?

70